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ABSTRACT

This four-volume student text is designed for use by Air Force personnel enrolled in a self-study extension course for apprentice still photographic specialists. Covered in the individual volumes are general subjects (career ladder progression, security, photographic safety, and photographic laboratory administration); still photographic fundamentals (existing and supplemental light sources, photographic exposure, sensitized black-and-white materials, photographic optics, and photographic filters); photographic camera assignments (principles of photographic composition, general and studio assignments, and reproduction photography); and photographic laboratory applications (black-and-white chemistry, film processing and finishing, printing, and finishing; principles of color photography; and quality control). Each volume in the set contains a series of lessons, exercises at the end of each lesson, a bibliography, and answers to the exercises. Volume review exercises are also included. (MN)

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APPRENTICE STILL PHOTOGRAPHIC SPECIALIST

(AFSC 23132)

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23132	APPRENTICE STILL PHOTOGRAPHIC SPECIALIST (AFSC 23132)	5 Oct 84

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3	VOL	VOL 1, General Subjects	23132 01 7808	
4	VRE	VOLUME REVIEW EXERCISE (VOL 1)	23132 01 22	23132 01 22
5	VOL	VOL 2, Still Photographic Fundamentals	23132 02 7905	
6	VRE	VOLUME REVIEW EXERCISE (VOL 2)	23132 02 22	23132 02 22
7	VOL	VOL 3, Photographic Camera Assignments	23132 03 7904	
8	VRE	VOLUME REVIEW EXERCISE (VOL 3)	23132 03 22	23132 03 22
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1. CHANGES FOR THE TEXT: VOLUME 3

a. Page 16, col 2, line 2 from bottom: Change "normal or wide angle" to "longer than normal focal length." Line 4 from bottom: Change "foreground" to "background." Figure 1-20: Change "Foreshortening" to "Diminution."

b. Page 17, col 1, line 2: Change "longer" to "shorter."

2. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 1

The following questions are no longer scored and need not be answered: 30 and 50.

3. CHANGE FOR THE VOLUME REVIEW EXERCISE: VOLUME 2

Page 2, question 7: In the stem of the question, change "quarts iodine" to "quartz halogen."

4. CHANGES FOR THE VOLUME REVIEW EXERCISE: VOLUME 3

a. Page 6, question 30, choice d: Change "investigate" to "investigating."

b. Question 4 is no longer scored and need not be answered.

5. CHANGES FOR THE VOLUME REVIEW EXERCISE: VOLUME 4

a. Page 2, question 6: Before "The" insert "(603)."

b. Page 15, question 108: Change "(680)" to "(680b)."

c. The following questions are no longer scored and need not be answered: 7 and 47.

23132 01 7808

CDC 23132

APPRENTICE STILL PHOTOGRAPHIC SPECIALIST

(AFSC 23132)

Volume 1

General Subjects

Extension Course Institute

Air University

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THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

Preface

THIS CAREER Development Course is designed to help you qualify for the duties and responsibilities of an Air Force Apprentice Still Photographic Specialist, AFSC 23132. The course consists of four volumes: this volume contains information on career ladder progression, security, photographic safety, and photographic laboratory administration; Volume 2 deals with photographic fundamentals; Volume 3 covers the different types of photographic camera assignments; and Volume 4, covers photographic duties within the laboratory.

If you have questions on the accuracy or currency of the subject matter of the text, or recommendations for its improvement, send them to the 3430th Technical Training Group/TTMZS, Lowry AFB CO 80230. Questions requiring immediate resolution may be directed to the course authors at AUTOVON 926-4142 between 0800-1600 hrs (MST) Monday through Friday. NOTE: Do not use the suggestion program to submit corrections for typographical or other errors.

If you have questions on course enrollment or administration, or any of ECI's instructional aids (Your Key to Career Development, Behavioral Objective Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If this agent can't answer your questions, send them to ECI, Gunter AFS AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 6 hours (2 points).

Material in this volume is technically accurate, adequate, and current as of May 1977.

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NOTE: In this volume, the subject matter is developed by a series of student-centered objectives. Each of these carries a three-digit number and is in boldface type. Each sets a learning goal for you. The text that follows the objective gives you the information you need to reach that goal. The exercises following the information give you a check on your achievement. When you complete them, see whether your answers match those in the back of this volume. If your response to an exercise is incorrect, review the objective and its text.

Career Ladder Progression

CONGRATULATIONS on your assignment as an audiovisual helper in the still photographic job specialty. As you begin studying this career development course (CDC), you are entering a highly professional and satisfying career field. As a photographer, you will be permitted and even encouraged to express yourself in your work. The rewards of your efforts in photography are the recognition you receive when your work is put on display on office walls, printed in base and local newspapers, or possibly in service-wide or national publications. Very few Air Force careers offer this special type of recognition for individual job accomplishment.

In this chapter, you should learn several of the factors that affect your progression in the audiovisual career field. As you begin your study of this CDC, keep in mind the following quote from AFR 35–1, *Military Personnel Classification Policy:*

> Individual Responsibilities. An individual's career progression, including promotion in the Air Force, is directly related to the efforts expended by the officer or airman to attain and maintain qualification in his specialty. Therefore, attaining and maintaining this qualification are primarily the responsibility of the individual. Classroom, seminar and independent study programs leading to onbase completion of degrees and certificates from military and civilian educational institutions, including programs of the Community College of the Air Force (CCAF) which incorporate specialty training with academic education are available through Base Education Service Centers. Each officer and airman is encouraged to avail himself of every opportunity for increasing his technical qualifications and enhancing his professional and military knowledge.

In view of the preceding, you see that the accomplishment of this CDC is your responsibility towad your career progression.

1-1. Airman Classification System

Let's begin our discussion with why you were assigned to the audiovisual career field. Perhaps you had a choice of jobs and this was your first choice. But if you are not doing exactly what you wanted, there is a reason for it. The needs of the Air Force come first.

001. Define the Military Classification System and state what the components of an AFSC mean.

The audiovisual career field is an integral part of the Military Classification System. This classification system identifies the duties required for each position essential in accomplishing the mission of the Air Force and accurately identifies the abilities of individuals in relation to the qualifications required to perform in these positions. Positions are grouped according to required common knowledge, skills, and other abilities into Air Force Specialties (AFSs) with each AFS having a specialty description, title, and number known as an AFSC (Air Force specialty code). You are presently striving for AFSC 23132.

Each specialty within the career field is identified by an Air Force specialty code. Each AFSC is identified by an Air Force specialty code. Each AFSC is identified by a five-digit number. The first two digits identify the career field. The third number, combined with the first two, identifies the career field subdivision. Skill level is shown in the fourth digit. There are five different skill level: 1 helper, 3 semi-skilled (apprentice); 5 skilled (journeyman); 7 advanced (supervisor, technician); and 9 superintendent. The fifth digit, combined with the other four, identifies the specific Air Force specialty. The 23132 AFSC you are now working for breaks as follows:

23	Career Field: Audio Visual
231	Career Field Subdivision: Photography
2313	Skill Level: Semiskilled (Apprentice)
23132	Specific Air Force Specialty: Apprentice Still Photographic Specialist

Exercise (001):

1. Complete the following statements by supplying the missing word(s):

   a. The classification system identifies duties of a job and the ______ of individuals in relation to those duties.

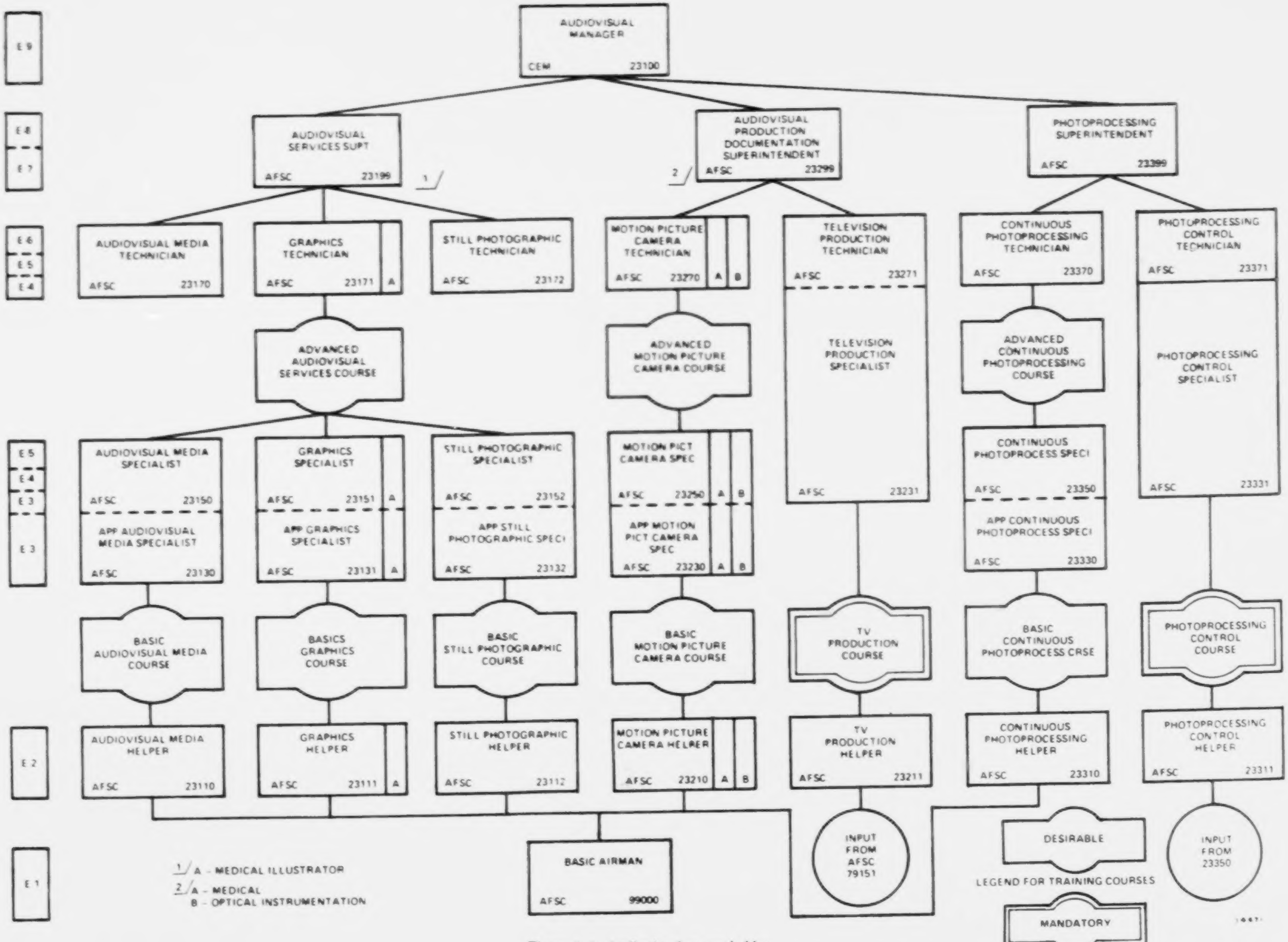
E 9
E 8
E 7
E 6
E 5
E 4
E 5
E 4
E 3
E 3
E 2
E 1
AUDIOVISUAL MANAGER
CEM 23100
AUDIOVISUAL SERVICES SUPT
AFSC 23199
1/
AUDIOVISUAL PRODUCTION DOCUMENTATION SUPERINTENDENT
2/
AFSC 23299
PHOTOPROCESSING SUPERINTENDENT
AFSC 23399
AUDIOVISUAL MEDIA TECHNICIAN
AFSC 23170
GRAPHICS TECHNICIAN
AFSC 23171 A
STILL PHOTOGRAPHIC TECHNICIAN
AFSC 23172
MOTION PICTURE CAMERA TECHNICIAN
AFSC 23270 A B
TELEVISION PRODUCTION TECHNICIAN
AFSC 23271
CONTINUOUS PHOTOPROCESSING TECHNICIAN
AFSC 23370
PHOTOPROCESSING CONTROL TECHNICIAN
AFSC 23371
ADVANCED AUDIOVISUAL SERVICES COURSE
ADVANCED MOTION PICTURE CAMERA COURSE
TELEVISION PRODUCTION SPECIALIST
AFSC 23231
ADVANCED CONTINUOUS PHOTOPROCESSING COURSE
PHOTOPROCESSING CONTROL SPECIALIST
AFSC 23331
AUDIOVISUAL MEDIA SPECIALIST
AFSC 23150
APP AUDIOVISUAL MEDIA SPECIALIST
AFSC 23130
GRAPHICS SPECIALIST
AFSC 23151 A
APP GRAPHICS SPECIALIST
AFSC 23131 A
STILL PHOTOGRAPHIC SPECIALIST
AFSC 23152
APP STILL PHOTOGRAPHIC SPECI
AFSC 23132
MOTION PICT CAMERA SPEC
AFSC 23250 A B
APP MOTION PICT CAMERA SPEC
AFSC 23230 A B
CONTINUOUS PHOTOPROCESS SPECI
AFSC 23350
APP CONTINUOUS PHOTOPROCESS SPECI
AFSC 23330
BASIC AUDIOVISUAL MEDIA COURSE
BASICS GRAPHICS COURSE
BASIC STILL PHOTOGRAPHIC COURSE
BASIC MOTION PICTURE CAMERA COURSE
TV PRODUCTION COURSE
BASIC CONTINUOUS PHOTOPROCESS CRSE
PHOTOPROCESSING CONTROL COURSE
AUDIOVISUAL MEDIA HELPER
AFSC 23110
GRAPHICS HELPER
AFSC 23111 A
STILL PHOTOGRAPHIC HELPER
AFSC 23112
MOTION PICTURE CAMERA HELPER
AFSC 23210 A B
TV PRODUCTION HELPER
AFSC 23211
CONTINUOUS PHOTOPROCESSING HELPER
AFSC 23310
PHOTOPROCESSING CONTROL HELPER
AFSC 23311
INPUT FROM AFSC 79151
INPUT FROM 23350
BASIC AIRMAN
AFSC 99000
1/ A - MEDICAL ILLUSTRATOR
2/ A - MEDICAL
B - OPTICAL INSTRUMENTATION
DESIRABLE
LEGEND FOR TRAINING COURSES
MANDATORY

Figure 1-1. Audiovisual career ladder.

b. Each specialty within a career field is identified by a ______ digit number called a (an) ______ ______ ______ ______ .

c. There are ______ different skill levels; they are:

002. Given a list of upgrade requirements, select those which are mandatory for award of AFSC 23132.

How Can You Earn the 3 Level? One way to achieve the apprentice level is to pass the AFSC 23132 apprentice knowledge test (AKT). This test is given to airmen who have had previous photographic experience. Upon passing the test, they can be assigned as a 3 level. Another way is to graduate from the Basic Still Photographic Course taught at Lowry Air Force Base, Colorado. Finally, you can achieve the 3 level the way you are doing it, through upgrade training while you are working on the job after being assigned directly from basic training.

NOTE: Each AFSC may limit the manner in which the 3 level may be earned. Certain AFSCs may require a mandatory basic course. Others may not offer any school and require OJT training.

Upgrade training. Upgrade training was developed to qualify Air Force personnel at the next higher level of job proficiency in the shortest possible time. Currently, the Air Force is using the dual-channel concept for upgrade training. As the name suggests, there are two parallel segments involved in the training. These segments are job proficiency and job knowledge. Job proficiency is accomplished by on-the-job training (OJT) and job knowledge is obtained through completion of career development courses (CDCs).

On-the-job training provides you with practical experience in performing the duties required by the specialty. This performance is accomplished under the close supervision of a qualified trainer. It allows you to demonstrate your ability to perform under actual working conditions.

The career development course you are taking is a self-instructional publication. It provides information on the concepts, principles, and basic knowledges required by your specialty. This information is provided to the level required by the specialty training standard (STS) developed for your specialty. Figure 1-2 shows the steps involved in the dual-channel training program.

NOTE: To attain your 3 level, in addition to completing this CDC and meeting your OJT requirements, you must have your supervisor's approval and have completed your training within 12 months.

Specialty qualifications. Changes or awards of an AFSC are based on standards from AFR 39-1, *Airman Classification Regulation,* and information from AFR 35-1. These standards are prescribed in paragraph 3 (Specialty Qualifications) of each specialty description. There are mandatory and desirable requirements in "knowledge," "education," "experience," "training," and "other." Mandatory requirements are minimums for the award of an AFSC. Desirable requirements aid in your ability to work in your AFSC. The following is an extract from the specialty description.

> 3. Specialty Qualifications
>
> *a.* Knowledge:
>
> (1) Knowledge of photographic theory, technology, and processes, including mechanics of camera, laboratory, and allied equipment; photochemistry and use of sensitized materials and filters; photographic layout and illustrations; pictorial aesthetics and composition; photographic methods of recording and displaying information; photographic laboratory techniques, and lenses is mandatory. Possession of mandatory knowledge will be determined in accordance with AFR 35-1.
>
> (2) Knowledge of photojournalism; picture editing, technical and documentary photography; and procedures for making negatives for offset and gravure printing is desirable.
>
> *b.* Education: Completion of high school with courses in photography and chemistry is desirable.
>
> *c.* Experience: Experience in functions such as still photography and photofinishing is mandatory.
>
> *d.* Training: Completion of a basic still photographic course is desirable.
>
> *e.* Other:
>
> (1) A minimum aptitude level of general 40 is mandatory.
>
> (2) Normal color vision as defined in AFR 160-43 or a score of 50 using VTA CTT is mandatory.

You met the mandatory requirements of item 3e before you were assigned to the still photographic specialty of the audiovisual career field.

Exercise (002):

1. From the following list of upgrade requirements, select those which are mandatory to attain the 3 level when you have been given a direct duty assignment.

   a. Completion of high school.
   b. Knowledge of photochemistry.
   c. Completion of the apprentice level CDC.
   d. Approval of your supervisor.
   e. Knowledge of picture editing.

003. Associate military grades with the proper skill levels.

Career Progression. Once you have completed your 3 level, you immediately begin working toward your 5 level. Promotion to the grade of senior airman is possible only if you hold the 3 level, and to staff sergeant if you have achieved the 5 level. Generally

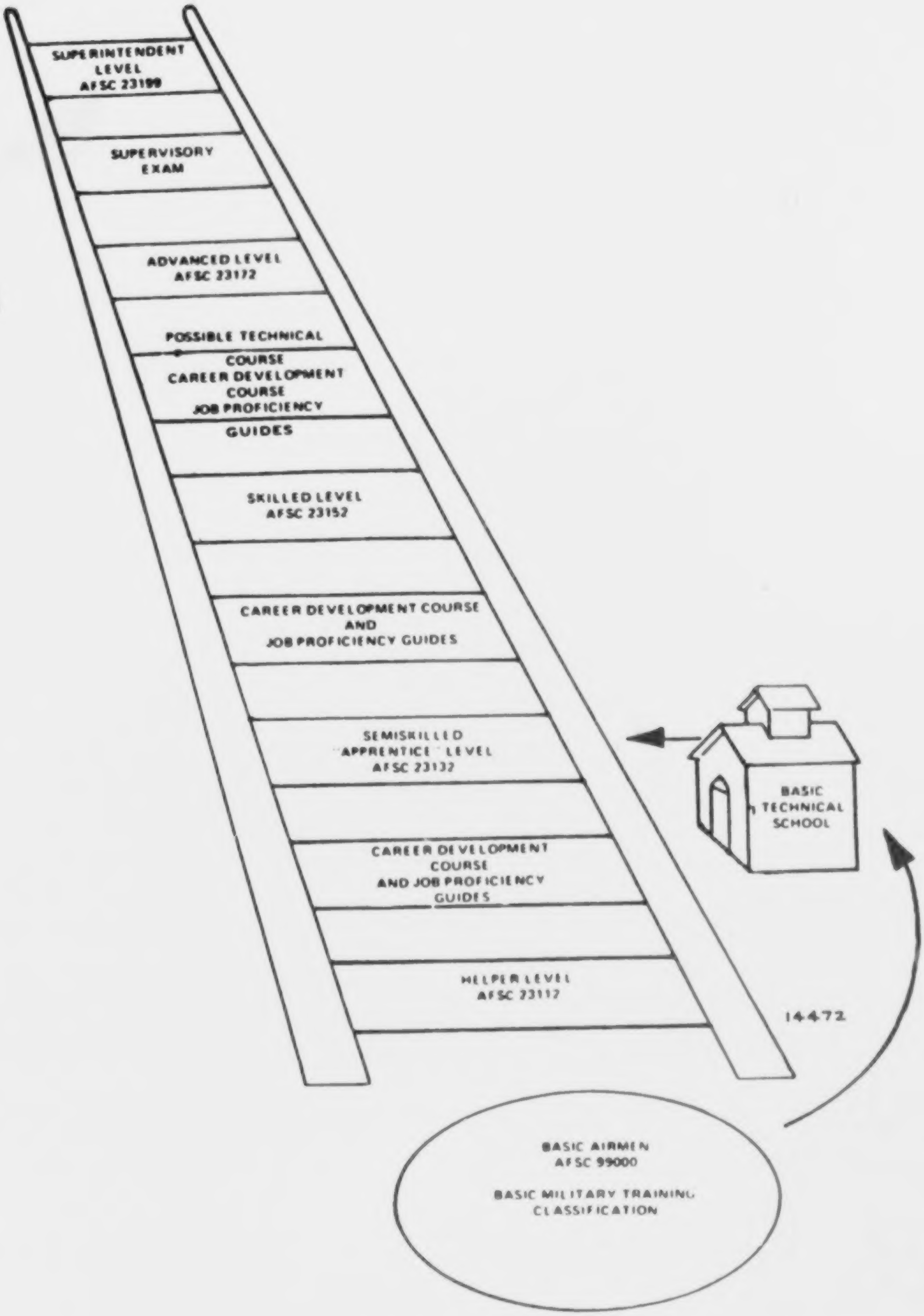
SUPERINTENDENT
LEVEL
AFSC 23199
SUPERVISORY
EXAM
ADVANCED LEVEL
AFSC 23172
POSSIBLE TECHNICAL
COURSE
CAREER DEVELOPMENT
COURSE
JOB PROFICIENCY
GUIDES
SKILLED LEVEL
AFSC 23152
CAREER DEVELOPMENT COURSE
AND
JOB PROFICIENCY GUIDES
SEMISKILLED
"APPRENTICE" LEVEL
AFSC 23132
BASIC
TECHNICAL
SCHOOL
CAREER DEVELOPMENT
COURSE
AND JOB PROFICIENCY
GUIDES
HELPER LEVEL
AFSC 23112
14472
BASIC AIRMEN
AFSC 99000
BASIC MILITARY TRAINING
CLASSIFICATION

Figure 1-2. Dual-channel training concept.

speaking, acquisition of AFSC 23152 is based on greater proficiency and understanding of 23132 subjects and limited supervisory functions.

You must continue training into AFSC 23172 to reach technical or master sergeant. At this level, airmen are expected to reach the highest required level of technical knowledge in their specialty. The greatest differences between AFSCs 23152 and 23172 lie in the areas of supervision and administration.

AFSC 23192 is awarded to master and senior master sergeants from AFSCs 23170, 23171, or 23172. These NCOs have passed comprehensive tests in management procedures and have been selected by board action. As this skill level is the culmination of years of dedicated service in the audiovisual career field, competition for it is very keen.

Exercise (003):

1. Match the grade listed in column A with the appropriate skill level in column B.

Column A	*Column B*
1 I 6	a. 23152
2 I 5	b. 23172
3 I 2	c. 23132
4 I 8	d. 23192
5 I 4	e. 23112

1-2. Duties of AFSs 23132/52/72

You were awarded AFSC 23112 upon completion of basic training. Now you are in upgrade training to the 3-level AFSC and, although you hold a 1 level, you are performing 3-level duties. Soon, upon award of your 3 level, you will perform 5-level duties, and then later on, you will assume 7- and 9-level responsibilities.

004. Identify the duties performed at the 3, 5, or 7 level.

The duties and responsibilities for both the 3 and 5 levels are given in paragraph 2 of the specialty description. This paragraph is quoted as follows:

> Duties and Responsibilities
>
> *a.* Prepares for still photographic assignments: Analyzes requirements. Performs pictorial research. Selects and checks camera, film, filters, lighting and accessory equipment. Prepares shooting outlines. Determines most appropriate means to photographically record and convey desired impression or information.
>
> *b.* Accomplishes still photography: Selects and uses appropriate lenses and accessories. Photographs controlled or uncontrolled subject matter. Visualizes and photographically conveys stores, events, or visual impressions. Accomplishes documentary, record, informational, and portrait photography. Obtains pertinent data and prepares captions or logs. Collects information and prepares background stories. Selects, designs, and crops layouts. Employs various visual elements and applies aesthetic principles of composition, proportion, balance, dominance and subordination. Coordinates with flight operations and pilots prior to and during photography of air-to-air, air-to-ground, and ground-to-air subjects. Directs aircraft positioning and maneuvers to depict desired visual effect.
>
> *c.* Operates still photographic camera and laboratory equipment: Uses still cameras and associated lighting equipment. Determines exposure values to achieve desired pictorial effects, using various exposure meters, filters, specialized lenses and accessories. Operates contact and projection printers; conventional film processing machines; film and print dryers; dry mounting presses; chemical mixing devices; diffusion process equipment, standard wet process, and line and continuous tone photographic reproduction equipment.
>
> *d.* Processes film: Processes black-and-white, color negative, and reversal film. Uses optimum time, temperature, and controlled agitation methods. Applies principles of physical and chemical development, reduction, intensification, cleaning, and fixing. Insures consistency in negative development and exposure, and initiates corrective action. Employs basic quality control techniques.
>
> *e.* Accomplishes photographic reproduction: Copies graphics and prints. Makes duplicate negatives, internegatives, interpositives, and transparencies using black-and-white or color duplicating films. Lights copy setups for desired effects using filters and other techniques to enhance detail, eliminate stains and blemishes and balance color. Tones black-and-white printes. Uses wetting agents, sprays, and waxes. Retouches and corrects defects. Obtains archival permanence and insures proper disposition of negatives.
>
> *f.* Mixes and ocntrols chemistry: Mixes processing and finishing solutions according to formula, using prepackaged and bulk chemicals. Safeguards against toxic or caustic chemical reactions. Employs data and conversion tables, and quality assurance graphs to establish and maintain technical consistency. Maintains solutions at proper strength and temperature, and insures all recoverable silver has been salvaged from laboratory wastes.
>
> *g.* Produces prints: Makes color or black-and-white contact and projection prints. Insures proper contrast and tonality. Chooses appropriate paper grades and filters. Achieves desired focus, cropping, format, print quality, finish, and size. Uses dodging, burning-in, and flashing techniques. Performs operator preventive maintenance on photographic equipment.
>
> *h.* Supervises still photographic personnel: Assigns duties to subordinates. Conducts on-the-job training.

If you were to look at paragraph 2 of the 23172 specialty description in AFR 39-1, you would find the headings as follows:

> *a.* Provides still photographic support.
> *b.* Performs still photographic assignments.
> *c.* Operates still photographic cameras and laboratory equipment.
> *d.* Controls color and black-and-white film processing and print production.
> *e.* Performs copy and reproduction functions.
> *f.* Regulates color and black-and-white laboratory chemistry.
> *g.* Performs quality assurance.
> *h.* Supervises still photographic personnel.

Notice that these headings are somewhat different from those in the 3- and 5-level specialty description. The 7-level NCO is responsible for such items as planning and scheduling work assignments, establishing work methods, production controls, and performance standards; insuring availability of maintenance equipment, tools, and spare parts; and establishing work priorities. He has to be more proficient in all the technical areas and is more heavily involved in supervision and task analysis than his 3- and 5-level subordinates.

Exercises (004):

1. At which skill level are you most likely to be asked to clean a processing machine?

2. At which skill level would you most likely be concerned with conducting 3-level OJT?

3. At which skill level would you most likely be concerned with planning and scheduling work assignments?

1-3. Training

The Air Force has all types of training available. By the time you have reached this point in your career, you may have experienced at least two types of training. First, you were given basic military training. Now, you are studying this CDC as part of your on-the-job training. You will continue with this type of training through your 5 and 7 levels. You may also be eligible for special training for certain parts of your job.

005. List the types of special training that are available and identify the contents of AFM 50-5.

Types of Training. The field training program of the Air Force is designed to conduct transition training to qualify skilled personnel on new or different types of equipment associated with their AFSCs. It conducts familiarization training for those who already have a fundamental technical knowledge but who need to learn the composition and functions of a specific system. Proficiency training is given to maintain a given skill level.

Special training is given to qualify skilled airmen who are retraining into a different career field or career ladder. Another type of special training is contract special training. This type of training, often referred to as factory training, is formal training conducted under contract with civilian industrial or educational institutions. The training is conducted either at the contractor's location or at an Air Force base. Contract special training is usually used when new weapon, command and control, or support systems are developed. Often, this type of training is used to develop an initial cadre of trained personnel until ATC can institute a training program.

Still another type of special training is ATC Special Resident Training. This training is formal training of a one-time or limited nature conducted by ATC instructors at an Air Force base. This type of special training is frequently used as a followup to contract special training.

Training Information Sources. If you need to find out what training is available, you should consult AFM 50-5, *USAF Formal Schools Catalog*. This two-volume manual lists all of the formal training courses conducted by the Air Force.

Let's see what information AFM 50-5 contains and how it can help you. Volume 1 of AFM 50-5 is divided into 13 chapters. Chapter 1 contains general information and instructions. Some of the items covered are general prerequisites for training. If you wish to go to school, you should consult Chapter 1 to find out whether you are eligible. For example, the length of a course determines the length of time that you must have remaining on your current enlistment in order to qualify for the training. This chapter also contains general application procedures and reporting instructions.

Chapters 2 through 13 contain information on courses monitored by major commands. In Chapter 3, information is available on Air Training Command courses.

This chapter starts with general information on ATC courses. It contains an explanation of the ATC course numbering system. It also contains reporting instructions for each base conducting ATC monitored courses. These instructions tell the earliest and latest reporting time and indicate to which building you report. Volume 2 of AFM 50-5 lists all courses by number. Each individual announcement contains the course number, title, length, a brief description, prerequisites, and necessary security clearance.

The following is the course announcement for the photojournalism course taught at Lowry AFB. We have included it to show you part of what is contained in AFM 50-5.

> G3AZR23152 001—Still Photojournalistic Techniques—PDS Code UOZ—DOD400—Lowry/6wk—Sep 76
>
> The photojournalistic process with emphasis on the photojournalistic sequence, information acquisition techniques, elements of style in writing, communication with people, legal and ethical aspects; tools of the trade, state of the art, with instruction on use of various processing techniques, with exercises to develop photojournalist's awareness of people pictures; job-oriented workshop emphasizing personality feature, groups, spot news, publicity, editorial sports, picture story and layout.
>
> Prerequisites: Amn: Min grade of Sgt E-4 with one year retainability; AFSC 5 or 7 level 231X2 or 791X0; must be fully qualified in actual camera operation; experience in Info Office photography desired. Civ: Equivalent qualifications. Off: Equivalent qualification, AFSC 23XX or 79XX. Personnel are encouraged to bring personal camera equipment to course. One copy of student's orders to arrive LTTC/TTMZS, Lowry AFB, CO 80230, 10 days prior to class start date.
>
> Quotas controlled by ATC/TTPP.

From this example you can tell that nearly everything you want to know about the photojournalism course (length, contents, grade, AFSC) is included in AFM 50-5.

Exercises (005):

1. List three types of specialized training.

2. What types of information can you find in AFM 50-5?

1-4. USAF Graduate Evaluation Program

Since nearly everything that is accomplished must be tested or evaluated, you are really no different. The graduate of Air Force training must be evaluated to see if the schools are producing an acceptable product. The next portion of this chapter deals with how the Air Force evaluates the graduates of its schools.

006. List three methods of field evaluation and four factors that can be determined through field evaluation.

Purpose. AFR 50-38, *Field Evaluation of Formal School Graduates*, establishes the requirement for a program to evaluate the graduates of Air Force formal schools. The program is a major aid in the quality control of both formal and career development courses. You may be asked to participate in the evaluation program after you finish this CDC. But if you are not, you should remember that some graduates will be asked, and that this evaluation will help the Air Force to achieve its purpose.

Methods. There are four methods used to get information from the graduates:

Field evaluation visit. In this type of evaluation, the graduate and supervisor are interviewed by a training expert. The interview is usually held at the graduate's place of work. The visit is within six months after the graduate has been assigned.

Direct correspondence questionnaire. A questionnaire is mailed directly to the graduate and his supervisor. Again this is done within six months after graduation. This method is obviously cheaper, and more graduates can be interviewed in a given time. This method is the one you are most likely to be involved in. If you are chosen, you will get a questionnaire when you take the course examination.

Job performance evaluations. Because of the cost involved in this type of evaluation, it is seldom used.

AF Form 1284, Training Quality Report. This is a form that the immediate supervisor fills out if: the graduate does not meet the required proficiency levels; the graduate is not required to do the duties of the STS; or the STS code levels exceed the requirements of the AFSC.

Factors To Determine. All of the methods used to gather information are designed to determine five specific factors:

a. The ability of the graduates to perform their duties as well as they are required to.

b. How much or how often the graduates use their new skills.

c. How well the graduates remember what they were taught.

d. Whether the STS or school needs to be changed.

e. Whether more evaluation is needed in specific areas of the career field.

Exercise (006):

1. List three methods of field evaluation and four factors that can be determined through field evaluation.

CHAPTER 2

Security

FROM TIME TO TIME, most photo labs are required to reproduce classified material for various Air Force agencies. As a still photographic technician, you are exposed to this kind of information as a part of your daily job. As a member of the Air Force, you are subject to regulations that require you to take every possible action to insure the security of classified information.

Department of Defense Regulation 5200.1-R, *Information Security Program Regulation*—the prime purpose of this regulation is to insure that official information of the Department of Defense relating to National security is protected, but only to the extent and for such periods as is necessary. The regulation establishes the basis for identification of information to be protected; prescribes a progressive system for classification, downgrading, and declassification; prescribes safeguarding policies and procedures to be followed; and establishes a monitoring system to insure the effectiveness of the Information Security Program throughout the Department of Defense.

In the Air Force, AFR 205-1, *Information Security Program*, supplements the DOD Information Program Regulation (DOD ISPR 5200.1-R) governing the classification, downgrading, declassification, and safeguarding of classified information. It is applicable to all Air Force activities, including the Reserve components. The DOD ISPR establishes standard DOD policies on the subject matter for all of the DOD components. This regulation amplifies those policies for use within the Air Force and provides procedural details where appropriate. *For this reason, neither the DOD ISPR nor this regulation should be used without reference to corresponding guidance contained in the other.*

Air Force Regulation 205-1 is quite specific concerning the individual's responsibility for controlling access to classified information. However, both regulations make it clear that each person whose duties require him to have access to classified information must understand the purpose and principles of the information security program and assume responsibility for protecting all classified information he knows or possesses.

AFR 205-1 specifies what information is classified, who classifies it, and how the classification may be downgraded or removed. It also sets forth procedures for transmission, storage, receipting, and destruction of classified material. If you are ever in doubt as to how to deal with a situation concerning classified information, use both regulations as guides for making decisions on what action to take.

This part of the text will help you to understand the types of information that may be of intelligence value to unauthorized persons. It identifies the official designations for classified defense information and spells out procedures for insuring the safe transmittal of this information. It also stresses the possibilities for committing security violations during voice communications and the precautions to take to avoid these pitfalls.

2-1. Types of Official Information

Any Air Force or Government information that you may come in contact with is *official information*. Official information is any information owned by, produced by, or controlled by the United States Government. This CDC is, therefore, considered official information.

007. Given a list of different types of official information state which information would be considered classified, unclassified, For Official Use Only, or unclassified but of possible intelligence value.

Official information is divided into two broad categories: classified and unclassified information. Classified defense information is official information, the safeguarding of which is necessary to prevent unauthorized disclosure in the interest of national defense and which is classified for such purposes by an appropriate classifying authority. For example, photographs (a form of information) of nuclear weapon experiments are classified information. Classified information is given only to a person whose official duties require a need-to-know, who has been given the appropriate security clearance, and who has the proper identification. Unclassified information is official information which does not require the application of security safeguards, but the disclosure of which may be subject to control for other reasons. For example, the orders assigning you to your first base after initial military training were unclassified.

Some official information, although unclassified, requires protection in the public interest. This information is labeled "For Official Use Only" and is withheld from widespread distribution to the public. You should not volunteer such information. For example, information in your personnel records is labeled "For Official Use Only."

Another subcategory of unclassified information is unclassified official information which is *of possible intelligence value*. Unclassified information which, when associated with other unclassified information, reveals an insight into or the specifics of classified plans, programs, operations, or activities becomes of possible intelligence value. For example, when you know a certain number of F-4s are on the runway, this information is unclassified. However, when you learn that they are armed with a certain type of weapon, you gain an insight into a classified plan. If you also learned that they were to be refueled in flight by a specific refueling squadron, you would have more information which you could put together and gain a further insight into a classified plan. Although none of these items by themselves may be classified, the information gained definitely has intelligence value.

It is easy to see why all classified defense information is of intelligence value and should not be revealed to anyone unless he is authorized to receive it. One of the biggest problems is that people cannot tell the difference between unclassified information and unclassified information of possible intelligence value. If you have any doubts, KEEP QUIET.

Exercise (007):

1. State whether each of the following pieces of information would be labeled "Classified," "Unclassified," "For Official Use Only, or "Unclassified but of possible intelligence value."

   a. Diagrams on a nuclear bomb system.
   b. Base movie schedule.
   c. "US Fighting Man's Code."
   d. The new flight of Tomcat aircraft is being loaded with Sparrow missiles.

2-2. Security Classifications

You have learned that classified defense information must be protected to prevent unauthorized disclosure. Whenever an unauthorized person gains knowledge of classified defense information, an unauthorized disclosure has occurred. This is a compromise of classified defense information. Classified information is divided into three categories: Top Secret, Secret, and Confidential. Although it is very unlikely that you will ever have to determine the classification of any information you receive, you should be familiar with classification procedures. With this knowledge, you will be better able to handle classified information.

008. Determine the classification of given pieces of information.

Security Classification Categories. Official information or material which requires protection against unauthorized disclosure in the interests of national security shall be classified in one of three categories: Top Secret, Secret, or Confidential, depending upon the degree of its significance to national security. No other categories shall be used to identify official information or material as requiring protection in the interests of national security, except as otherwise expressly provided by statute.

Top Secret. Top Secret refers to that national security information or material which requires the highest degree of protection. The test for assigning Top Secret classification shall be whether its unauthorized disclosure could reasonably be expected to cause exceptionally grave damage to the national security. Examples of "exceptionally grave damage" include armed hostilities against the United States or its allies, disruption of foreign relations vitally affecting the national security, the compromise of vital national defense plans or complex cryptologic (i.e., code) and communications intelligence systems, the revelation of sensitive intelligence operations, and the disclosure of scientific or technological developments vital to national security. This classification is used with the utmost restraint.

Secret. Secret refers to that national security information or material requir~~es~~ing a substantial degree of protection. The test for assigning Secret classification shall be whether its unauthorized disclosure could reasonably be expected to cause serious damage to the national security. Examples of "serious damage" include disruption of foreign relations significantly affecting the national security, significant impairment of a program or policy directly related to the national security, revelation of significant military plans or intelligence operations, and compromise of significant scientific or technological developments relating to national security. The classification, Secret, shall be used sparingly.

Confidential. Confidential refers to that national security information or material which requires protection. The test for assigning Confidential classification shall be whether its unauthorized disclosure could reasonably be expected to cause damage to the national security.

Figure 2-1 is a sample of a classification guide. To use the guide, follow these three steps:

a. Upon learning the new information, group it under a general type of information (A, B, C, D, E).

b. Look to the right to find the square that contains the specific information you are classifying.

c. Determine the protection required for the information.

Let us see how these steps can be used. Suppose you have to classify a photograph of a new aircraft cannon that is a modification of an existing gun. The improvements cause the weapon to fire faster with more accuracy. Applying the three steps, you would look first to the general categories. A cannon would fit under category B for weapon systems. Then looking to

	I CLASSIFY TOP SECRET IF DISCLOSURE COULD:	II CLASSIFY SECRET IF DISCLOSURE COULD:	III CLASSIFY CONFIDENTIAL IF DISCLOSURE COULD:	IV MARK FOR OFFICIAL USE ONLY IF DISCLOSURE COULD:
A INTELLIGENCE EFFORTS	REVEAL OWN SUCCESS AND OR CAPABILITIES BY ALLOWING FULL EVALUATION OF EFFORT.	REVEAL FACT WE KNOW POTENTIAL ENEMY MATERIAL, TROOP DISPOSITION, ETC.	COMPROMISE SOME INTELLIGENCE AND COUNTER INTELLIGENCE REPORTS.	REVEAL INFORMATION FURNISHED BY FOREIGN NATIONS IN CONFIDENCE.
B WEAPONS SYSTEMS	(1) DISCLOSE NUCLEAR DATA, (2) COMPROMISE RADICALLY NEW AND EXTREMELY IMPORTANT EQUIPMENT.	COMPROMISE DATA RELATING TO NEW DEVELOPMENTS.	REVEAL PRODUCTION AND PROCUREMENT OF MUNITIONS. SOME TECHNICAL TRAINING MANUALS.	REVEAL CERTAIN TECHNICAL DATA RELATING TO ARMS WHICH ARE SUBJECT TO EXPORT LICENSING.
C FORCE COMPOSITION AND DEPLOYMENT	COMPROMISE WORLD-WIDE COMPOSITION AND DEPLOYMENT IN WAR PLANS.	REVEAL STRENGTH, IDENTITY, EQUIPMENT COMPOSITION, AND LOCATION OF UNITS ENGAGED IN HOSTILITIES.	REVEAL STRENGTH OF GROUND, NAVAL, AND AIR FORCES IN THE U.S. AND OVERSEAS.	REVEAL INFORMATION PERTAINING TO SPECIFIC UNIT IDENTIFICATION, CURRENT LOCATION, AND GENERAL NATURE OF EQUIPMENT. ORDERS TO AN AREA OF UNDECLARED WAR.
D POLITICAL-MILITARY INFORMATION	(1) LEAD TO A DEFINITE BREAK IN DIPLOMATIC RELATIONS. (2) RESULT IN AN ARMED ATTACK AGAINST THE U.S. OR ITS ALLIES.	JEOPARDIZE INTERNATIONAL RELATIONS.		
E OPERATIONS	COMPROMISE STRATEGIC PLAN DOCUMENTING OVERALL CONDUCT OF WAR.	COMPROMISE PLANS THAT REVEAL MILITARY CAPABILITY OR PREPAREDNESS.	REVEAL OPERATIONAL AND TECHNICAL DOCTRINE/ RADIO FREQUENCIES AND CALLSIGNS OF SPECIAL SIGNIFICANCE.	231-513

Figure 2-1. Security Classification Guide

the right of B, you would choose the second column that identifies "compromise data relating to new developments." Finally, looking at the top of the column, you would find that the photograph should be labeled Secret.

Exercise (008):

1. Using figure 2-1, decide whether each of the following pieces of information should be labeled Top Secret, Secret, Confidential, or For Official Use Only.
   a. A particular new laser weapon can destroy incoming missiles.
   b. An enemy missile unit is being moved to within 5 miles of the fighting front.
   c. The United States has 60 B-52 bomber wings.
   d. The new radio frequency for in-flight communication between fighter elements is 126.1.
   e. The C-5A wing stationed at Travis AFB is being transferred to Andrews AFB.

2-3. Communications Security (COMSEC)

The Air Force uses many different types of communication in conducting official business. These range from conversation between two persons to various modes of sophisticated telecommunications. Frequently, classified information must be communicated. When this is the case, it is necessary to take proper precautions to insure that unauthorized personnel do not gain access to the information. At the same time, it is important to consider the speed of delivery and the reliability of the mode of communication selected.

069. Select modes of transmission as appropriate for specified types of information and speed requirements.

Modes of Communication. The four basic modes of communication are: messenger, mail, telephone, and radio. Each of these methods must be judged in terms of *reliability*, *security*, and *speed*. Reliability is a guarantee that a message will be delivered to the right person. Security means that there is little chance of the information being lost or compromised. Speed is the time it takes for the message to get from the sender to the receiver.

Messenger. Information sent by messenger is hand-carried from the sending office to the receiving office. This method is very secure and reliable, but slow. It is suitable for all types of classified information. The best time to use a messenger is when large volumes of classified material must be sent out.

Mail. Though mail does receive the protection of the Postal Service, it is not as secure and reliable as messenger delivery. Because of its limitations, mail cannot be used to send Top Secret information. Registered mail, however, can be used for communication of Secret and Confidential material. Keeping these restrictions in mind, mail is suitable for shipment of documents within the United States when time is not critical and a cheaper method than messenger delivery is an advantage.

Telephone. The telephone is quick and easy to use, but it is quite insecure. It is very easy for telephone communications to be intercepted (bugged). The telephone, therefore, may not be used to communicate classified information or information of possible intelligence value.

Radio. Different types of radios and teletypes provide the same convenience and speed of telephone unless operated under certain climatic conditions. Just like the telephone, wireless communication can be monitored. To overcome this insecurity, all classified information sent by radio must be encrypted (coded).

Exercise (009):

1. Decide whether messenger, mail, radio, or telephone would be the best mode of communication in the following situations. Remember to consider the factors of reliability, security, and speed in your decisions.

   a. You have a 200-page Secret report to deliver to a base 25 miles away.

   b. You are stationed at Andrews AFB, and a classified message must be sent to Paris as soon as possible.

   c. You have several Confidential reports to send to several bases within the next 2 weeks.

2-4. Voice Communications

The main reason the telephone is unacceptable to communicate classified information is its poor security. There is no way of telling who, besides the intended recipient, is listening to the conversation. The unauthorized listener may be a switchboard operator, a lineman, someone on another extension, or a user of an illegal wiretap. Although it is obvious that the telephone is not to be used to transmit classified information, it is one of the fastest, easiest, and most available modes of communication. These factors lead to the improper use of the telephone.

010. Identify methods related to the improper use of the telephone.

One of the common problems we encounter in using the telephone is *poor physical security*. One reason for this problem is that the telephone can pick up background conversations. For example, you receive a phone call asking for some information. While you go to the file cabinet to get the information, you lay the telephone receiver down on your desk. In the meantime, two or three other persons are discussing the contents of a classified chart. You have no way of knowing who may have overhead the conversation.

In order to prevent this situation from occurring, others in the room should refrain from classified discussions when the phone is in use. In our example, you receive the phone call, so the others should have known you were on the phone. However, when they saw you at the file cabinet, they may have assumed that you had completed your call. To prevent such a situation, you could have told the others in the room that the phone was still open.

Another situation where classified information may be given inadvertently over the telephone is one in which you are trapped by time. This is usually a result of *poor planning*. It could occur in a case where you had ample time to deliver the information in person but waited too long and ~~had~~ to use the telephone to meet a deadline. decided

Sometimes classified information may be given over the telephone because of *awe of rank* or position. Just because the person wanting the information is of high rank or holds a responsible position is no reason to give him the information he needs over the phone. If you get caught in this situation, inform the caller that the information is classified or sensitive and that you will see that it is delivered to him in the proper manner.

You may believe that you can cleverly disguise classified information when you use the telephone. What is wrong with this thinking? First, let us look at the situation known as *talk-around*. This is a case where you try to get the information across by changing the words. For example, if you refer to parts of a classified system as the thing in the lower right of the big black box under the rear seat, you have attempted to talk around and disguise the information. However, any person who would go to the trouble of monitoring a telephone conversation would know enough to determine what you actually meant.

Very closely related to talk-around is *paraphrasing*. The big difference is that talk-around gives the impression of double talk, while paraphrasing is using different words to say the same thing. For example, to say that the repetition of the output waves occurs 1234 million times a second means the same as the output frequency is 1234 MHz. Again, any spy could see right through your disguise attempts.

Another faulty try is using incomplete or *partial references*. If you were talking about the NA/ASQ-91 Weapon Release Computer on the phone and referred to it as the 91, you would be using an incomplete reference. Again, if you were discussing specifications of the sytem, it would be ridiculous to assume that an eavesdropper would not know what system you were talking about.

Some try to get around the problem by using a *self-made reference system*. This is an attempt to encode your own conversation by using your own code words. Such a system rarely works because few people are clever enough to refer to an item of information without actually revealing names, subjects, etc., in the information.

Consider, too, that the discussion of unclassified information may cause problems. Gossip, chatter, and idle or unnecessary talk over the phone may give out more information than you realize. For example, if you tell your buddy you can't go camping this weekend because you have a rush printing job may, when coupled with other bits of information, indicate the delivery of a new weapons system. Als, because you are tired, upset, or excited, you may let slip classified information of possible intelligence value. The main idea, therefore, is to use the phone only for official business of unclassified information.

Exercises (010):

1. When classified information is overheard through an unattended telephone transmitter, this is a result of _______ _______ _______.

2. If you give classified information over the phone because you are trapped for time, it is probably a result of _______ _______.

3. If you give Colonel Jones classified information over the phone, it is probably because of _______ _______ _______.

4. List four methods used to disguise classified information over the phone.

2-5. Operations Security (OPSEC)

The Air Force Operations Security (OPSEC) Program, prescribed by AFR 55-30, *Operations Security*, is an overall security program designed to enhance mission effectiveness. It is concerned with the information and activities that are sensitive because they give a hint to our enemy of our punch: they give the enemy forewarning. OPSEC is intended to reduce the enemy's capability to collect useful intelligence data about our operations and activities.

The first OPSEC program dealt with operations in Southeast Asia. Its purpose was to prevent the enemy from gaining prior knowledge of our operations by taking actions that denied him specific information that would decrease our effectiveness. Security procedures helped identify and eliminate those areas of activity patterns that showed the enemy something was going to happen. The present OPSEC Program was established in 1970. It was expanded to include all personnel and agencies connected with or having a knowledge of any operation, event, project, or program that required protection.

011. State the purpose of OPSEC, list OPSEC vulnerabilities, and indicate how OPSEC affects you.

Purpose. One of the basic principles of war is the element of surprise. OPSEC is concerned with keeping tactical and strategic advantage on our side. We must protect knowledge of our plans, resources, and limitations. Proper protection of classified information and material is part of it; so is protection of what seems to be trivial or insignificant. In other words, we must protect what is sensitive. The purpose, then, of OPSEC is *to prevent the disclosure of information containing intelligence indicators that can be used to degrade operational effectiveness.*

Vulnerabilities. OPSEC weaknesses fall into three major areas: operations, procedures, and communications. To assist you in your daily activities we have included the following list of potentially weak areas.

Operations.

a. Sterotyped sequences of events.

b. Coordination with other agencies that do not have proper safeguards.

c. Stereotyped flight patterns.

d. Submission of unclassified reports at specific times to specific units or levels of commands.

Procedures.

a. Public Information releases.

b. Posting and/or transmission of operation orders, flight plans, or air traffic control clearances, etc., in unsecure areas.

c. Posting duty rosters, transportation schedules, or dining hall schedules.

d. Distinctive emblems or paintings on vehicles, buildings, or aircraft.

e. Markings on supplies, which could show the location or starting date of an operation; that is—nicknames, delivery deadlines, etc.

f. Logistics buildup or positioning of support materials and facilities.

g. Special briefings, meetings, or religious services.

h. Nicknames are a particular hazard since they flag numerous actions associated with a particular operation.

i. Exercising the plan or testing portions of a plan.

Communications.

a. Plain language communications that are associated with a planned operation and conducted during the planning, preparatory, and execution phases.

b. Use of unchanging or infrequently changed call signs or radio frequencies.

c. Stereotyped message characteristics (voice or teletype) which indicate particular types of military activity.

d. Significant increase or decrease in message traffic volume.

e. Activities of new communications facilities in support of a planned operation.

OPSEC And You. As a photographer, you probably will come in contact with more classified information than the majority of the other career fields. You may be called on to produce pictures of classified equipment, material, or even restricted areas. Some of your work will involve duplicating classified slides or copy work. Since you know these things are classified, you won't discuss them. But what about the unclassified but sensitive information you handle?

Suppose your lab is duplicating slides on jungle survival. The contents of the slides may not be classified but the fact that you are stationed in Alaska adds significance to the information.

You may go into a restricted flightline area to take an unclassified picture of an award ceremony. While you are there, you see packing crates addressed to "Operation Nighthawk." The fact that you saw them is not classified. However, if you let it slip that you wonder where "Nighthawk" is, you may be passing on an intelligence indicator to a hostile agent.

Remember, as a photographer, you will see, hear, and document more sensitive information than most other Air Force people. Don't try to impress people with this knowledge. Keep it to yourself.

All forms of security contribute to one objective: Mission effectiveness. Information security, communications security, and operations security all enable us to keep an advantage over a possible enemy by denying him information about OUR activities and plans. If *you* keep all of this information in mind and remember the key points of security, *you* will never become a security risk.

Exercises (011):

1. State the purpose of today's OPSEC.

2. Why should you be particularly concerned with OPSEC?

3. What are the three major areas of OPSEC weaknesses?

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CHAPTER 3

Photographic Safety

ACCIDENTS DO NOT happen without cause. Accident records show that of all accidents, 88 percent are caused by unsafe acts of people, 10 percent by unsafe conditions that people allow to exist, and only 2 percent by natural disasters. The identification, isolation, and control of these causes form the backbone of accident prevention programs.

Certain phases of photographic work have a potential for producing accidents. Some of the work is performed in total darkness or under extremely low levels of illumination. Many photographic processes require the use of chemicals that, if used improperly, can cause serious injuries. However, if you are aware of the potential danger, and if you exercise the safety precautions covered in this text, the chances of your being involved in an accident are extremely limited.

You should begin to develop good safety habits now. Accidents result in pain and suffering, needless waste of manpower and materials, and could result in failure to carry out the assigned mission of the unit. For this reason, safety is stressed throughout your training. Protect yourself from possible accidents by paying close attention to the prescribed safety policies and procedures. To do the job right, you must do it safely.

The following text information covering electrical, chemical, compressed gas, and mechanical safety is meant to help you deal with some of the common safety problems you may encounter.

3-1. Electrical Hazards

In a still photographic facility, you are continuously working with electrical equipment. Although adequate training in equipment operation and proper instruction in safety requirements can help to reduce accidents caused by electricity, there is still the possibility of human error—that incalculable "something" that makes ground safety programs necessary. Often, airmen are so thoroughly familiar with their assigned tasks that they become negligent and the negligence results in preventable accidents.

012. Specify the actions that should be taken to reduce electrical hazards.

Many items of equipment used in a photographic facility are electrically powered. To reduce the possibility of electrical shock, burns, and equipment damage during use, special safety precautions should be taken. For safe operation, you should check power cords for worn or frayed insulation, loose connections, and broken parts. You should regularly check electrical equipment to insure that it is properly grounded. Be sure that all power cords have polarized, three-prong plugs attached. You can reduce the chances of being shocked by removing items of jewelry, such as rings, watches, and bracelets, and make sure your hands are dry before operating machines.

Overloading electrical circuits is extremely dangerous and is not permitted at any time. All systems installed in Air Force installations are equipped with fuses, circuit breakers, or other approved means to prevent accidental overloading. Use only fuses of the proper capacity. Never, under any circumstances, use tinfoil, solder, or other materials in place of a fuse. Never position items of electrical equipment, such as timers, where they can be accidentally knocked into a darkroom sink.

Exercise (012):

1. Which of the following actions are safe practices?

   a. Use polarized, three-prong plugs.
   b. Have personnel wear metal identification bracelets at all times.
   c. Overload circuits.
   d. Use circuit-breakers.
   e. Perform regular inspections.
   f. Use solder as a temporary fuse.

3-2. Chemical Safety

Some of the chemicals used in photography are only skin irritants, but others can cause more serious injuries. All chemicals should be regarded as potential poisons and should be handled with caution. Acids and caustic alkalies are dangerous and can cause severe burns if they come into contact with the skin. Some chemicals generate heat and may start fires when in contact with other materials. The following rules are to get you started thinking and practicing chemical safety.

013. Identify correct practices for working with photographic chemicals.

Here are some of the precautions you should take when you handle or mix photographic chemicals:

a. Never smell a chemical directly from the bottle. Instead, hold the bottle at a little distance from your nose and sniff its odor cautiously rather than inhaling deeply.

b. Never taste a chemical.

c. Handle all chemicals cautiously; some can produce burns or skin irritations.

d. When necessary, wear proper protective equipment and clothing. When working with caustic chemicals or acids, wear a rubber apron, rubber gloves, and goggles. If you are mixing powdered chemicals, use a respirator to prevent inhaling the dust.

e. When diluting strong acid with water, *add the acid slowly to the water* while stirring continuously; otherwise, the solution may boil violently and splatter on your face and hands, causing serious burns. Remember: ALWAYS ADD THE ACID.

f. Be sure that the chemical mixing room is well ventilated. The fumes and dust from some photographic chemicals will irritate your nose and eyes.

g. Store chemicals in airtight containers in a cool, dry place away from the sensitized materials. Chemical dust, and vapors can damage paper and film emulsions. Be sure that chemical containers are labeled properly.

h. If you spill caustic or toxic chemicals or acids on yourself or someone else, remove the soiled clothing and wash the affected area with a lot of water. Then get medical help as soon as you can.

i. Nearly all of the chemicals you will come into contact with in a photo lab are acid, alkali, or petroleum base. DO NOT induce vomiting if you or someone else swallows photo chemistry; instead, get medical help immediately. Tell the medical people exactly what was ingested.

j. If chemicals, either powder or liquid, get into your eyes, wash them immediately with lots of water.

Exercise (013):

1. Read the following statements and check the ones that describe safe practices when you are working with photo chemicals.

   a. Wear a respirator when you mix powdered chemicals.
   b. The best way to identify a chemical is to taste it.
   c. When you are mixing water and acid, always add acid.
   d. Store chemicals in airtight containers.
   e. If photo chemicals are swallowed, induce vomiting.
   f. If you get chemicals in your eyes, wash them with lots of water.

3-3. Compressed Gases

In some still photographic facilities, compressed gases, such as nitrogen or compressed air, are used daily. Though not lethal in themselves, these compressed gases do pose a special type of safety hazard.

014. Cite two potential safety hazards associated with the use of compressed nitrogen gas.

The most frequently used form of compressed gas is nitrogen. Nitrogen is an odorless, colorless, tasteless, and chemically inert gas which is neither corrosive, explosive, nor flammable. Compressed nitrogen is used for gaseous-burst agitation. (Gaseous-burst agitation requires the release of a burst of nitrogen gas at controlled intervals through a series of tiny holes located in a distributor device placed at the bottom of a processing tank. When correctly monitored and first released, the nitrogen burst imparts a sharp displacement pulse, much like a piston, to the entire processing solution. Then, as the bubbles make their way to the surface of the solution, a localized agitation actioin is provided around each bubble. By virtue of their great numbers and the random paths made to the surface, the nitrogen bubbles provide effective agitation at the surfaces of film or paper suspended in the solution.)

In some laboratories, cylinders of compressed air are used in equipment having air bearings, air squeegees, or pneumatic systems.

After what has just been said, you might wonder how compressed gas could produce a situation that could be hazardous to you. Actually, it can be dangerous in two ways. First, since it is compressed, there is quite a large volume of gas present in the container. If it is released in a confined area where there is a lack of adequate ventilation, nitrogen gas could easily asphyxiate you. Since nitrogen is odorless, colorless, and tasteless, it would be almost impossible to identify the hazardous situation until it was too late. Good ventilation and careful inspection to insure that hoses and fittings are in good condition and properly connected will eliminate this potential hazard.

Secondly, because the gas is compressed, its container is a source of danger. It must be handled carefully to avoid being damaged. If the top is cracked or broken, the escaping gas would turn the cylinder into a deadly projectile. Although accidents occur infrequently, the possibility exists; so remember to handle the gas cylinders with care. Secure all gas cylinders to prevent them from being accidentally knocked over. This is easily done by chaining them to a wall.

Exercise (014):

1. From the following list, choose the two potential safety hazards associated with compressed nitrogen gas.

   a. The gas could cause asphyxiation.
   b. The cylinder could release lethal gas.
   c. The cylinder could become an unguided missile.
   d. The cylinder could burst into flames.

3-4. Connecting and Disconnecting Tanks of Compressed Gas

At times, it may be necessary for you to disconnect an empty gas cylinder and connect a full cylinder to complete your mission. Therefore, you should know the proper procedures before trying to do this task. The following paragraphs are a summation of the procedures described in Technical Order 42B5-1-2, *Gas Cylinders (Storage Type), Use, Handling and Maintenance*.

015. Indicate the procedures used to connect tanks of compressed gas.

Connecting Tanks of Compressed Gas. The first step in connecting a new gas cylinder is to crack or open the valve slightly. This will blow any dust or debris out of the valve. After re-closing the valve, attach the regulator or union. You must insure that threads on the regulator or union are the same as those on the cylinder valve. If the fittings are hard to turn, do not force them. Check to be certain that the threads are correct and are not damaged. Threads must be of the same type and have the same number of threads per inch to be engageable and to produce a satisfactory seal. After attaching the regulator to the cylinder valve, check to see that the adjusting screw on the regulator is released before opening the cylinder valve. When this is done, the lines can be connected to the regulator.

Disconnecting Tanks of Compressed Gas. The procedures for disconnecting tanks of compressed gas are basically the reverse of connecting the tanks. However, cracking the cylinder valve is not necessary.

Exercise (015):

1. List, in sequence, the steps in connecting a compressed gas cylidner.

3-5. Mechanical Safety

With any type of equipment, there is always an inherent safety problem. Trimmers have sharp edges that can cut; processing machines have gears that can pinch. The list of potential dangers is limitless. However, an alert individual, following the established safety practices, can avoid becoming a victim of these hazards. Remember, most safety rules are established as a result of someone's unfortunate experience. Don't you provide a reason for making a new rule.

016. Identify conditions, common to all machine operations, that can lead to personal injury.

Plan Your Work. The more thoroughly you plan your work, the more likely you are to do it properly and safely. When you perform a task without first planning for it, you usually do many unnecessary operations, make many mistakes, and use many unsafe procedures. Since efficiency and safety are two of your most important considerations, it is essential that you plan your work thoroughly before you do it. During this preoperational planning, you should organize all operations necessary to complete the work properly, efficiently, and safely.

The most important idea to bear in mind when planning a job is to check all pertinent safety instructions. These may concern such materials as protective clothing, machine guards, or the type of equipment you are using. Be sure to study safety instructions carefully, especially if you are doing a job for the first time. As you begin work each day, even on comparatively simple tasks with which you are familiar, plan ahead to be sure all pertinent safety principles are observed. If protective devices are required, have them available.

Just what does good discipline have to do with you and safety on the job? Perhaps we can best illustrate this by an example. Let's say that you are operating a processor. The local operating instructions tell you never to remove the side panels unless the machine is turned off. This is to prevent getting hands or loose clothing caught in moving gears. However, you've done the job so many times that you know you can remove the cover without getting caught in the gears. So you ignore that caution and leave the machine running while removing the cover. Chances are you may get by with it once or maybe several times. However, you are just possibly betting your arm that you can get by with breaking the law of good discipline. You know better, but since "old Sarge" isn't there to enforce the law, you think you can get away with shortening the procedure. You may cheat on safety some of the time, but rarely all of the time, without getting caught. Remember, once may be too often.

Stay Alert. Another basic principle of safety is alertness. Constant alertness is definitely a prime requisite in avoiding accidents. Fundamentally, alertness means paying attention, not just now and then, but all of the time. Unless you pay close attention to what you're doing at all times, you undoubtedly end up doing something wrong; again, you have a situation in which an accident may happen.

The enemies of alertness are external and internal distractions—things that occur outside of you and things that occur inside of you, either mentally or physically.

Perhaps, the most serious disturbances are those that you and your buddies create. It is inexcusable for you or your buddy to do anything that could cause you or someone else to have an accident. This type of external distraction usually takes the form of horseplay.

There are quite a few kinds of internal distractions that may destroy alertness. Whether they are mental or physical, the number of possible internal distractions is just too many to cover in detail. However, let us talk about a couple of them so that we can see the importance of keeping mentally and physically alert while on duty.

A mental distraction is perhaps most often caused by thinking about personal problems rather than concentrating on what you are doing. This violates the principle of alertness. The reason that mental distractions are especially hazardous is that it is impossible for most people to pay attention to more than one thing at a time. Unless you are a rare exception, you had better forget about personal problems while working. If your personal problems are so great that they interfere with your work, let your supervisor know. He may be able to help you solve them. Don't let your personal problems make you cause an accident that damages equipment or hurts somebody. This would create even bigger problems.

Another common mental distraction is daydreaming. This is particularly dangerous, since your mind can become completely absorbed in the pleasantness of a daydream, and your alertness is destroyed. There are very few of us who haven't occasionally been caught napping by a sudden emergency that we otherwise would have seen. Don't permit idle thoughts to destroy alertness. It can cause an accident.

The other kinds of internal distractions are physical. The most prevalent kinds are fatigue, severe pain, and illness. Most of us take care of severe pain and illness, or at least we should. The problem of fatigue cannot always be eliminated. When you become fatigued, you should recognize it and not let it go too far before you inform your supervisor.

Exercises (016):

1. From the following list, identify conditions, common to all machine operations, that might lead to personal injury.
    a. Organizing work operations.
    b. Planning a camping trip while operating a paper cutter.
    c. Keeping physically fit.
    d. Disregarding operating instructions.
    e. Poor work planning.
    f. Mental distractions.

26

CHAPTER 4

Photographic Laboratory Administration

IT IS NOTEWORTHY that in the Air Force, as you increase your knowledge and improve your ability, you earn higher and higher rank; and with increased rank, you are given increased responsibility. With each subsequent step in grade, you can expect to assume some supervisory responsibilities. As a laboratory manager, not only should you have a thorough technical background, but you must also cope with an amazing amount of paperwork. Later, you will be running a complex operation, and it takes a lot of forms, work orders, routing slips, data records, and control charts to insure its effective and successful operation. In addition, there are regulations and operating instructions to cover just about everything, and you must understand and use them. All of this paperwork is the responsibility of the laboratory manager.

Although right now you are taking directions rather than giving them, by learning a few of the problems of administration you will better understand what you are being asked to do. Specifically, in this chapter we cover work requests and logs, files, publications, forms and reports, audiovisual records disposition, and copyright and reproduction restrictions.

4-1. Work Requests and Logs

A photographic laboratory should be run like any other business. Certain principles of good business management are applied to photo lab operations to insure an efficient operation. Each Air Force organization is given a specific operating budget within which they are expected to operate. Also, the mission of the organization and the workload involved determines the number of people assigned. The money expended to produce photographic products and the manpower required to produce them are expense factors that must be accounted for. Future budget and manpower requirements are mostly based upon what it cost the year before to operate the photo lab.

017. State the importance of properly completing the AF Form 833 and state who fills in specified blocks on the form.

Probably the most useful and important form used in a photographic laboratory is AF Form 833, Request For Audiovisual Services (fig. 4-1). When properly completed, the work request becomes the source for all pertinent information on a photographic assignment including the cost of materials and the manpower required to complete the assignment.

The work request is originated by the requester who completes blocks 5–15 on the front side of the form. Laboratory administrative personnel complete blocks 16–21. Here, the information provided by the requester is translated into specifics of the job to the done, and the types of finished products to be made. Photo lab personnel completing blocks 16–21 must be very knowledgeable in the scope of photo lab operations; including capabilities and work priorities.

The back of AF Form 833 (fig. 4-1A) provides spaces to record workload data and photo lab routing while the job is in-house. This is probably where you will use the form. You may be the photographer or, perhaps, you will process the film. Be sure that your figures are accurate when you record the time you spent on the task and the materials that you used. These figures from all work requests are added up at the end of each month to determine operating costs. When a work request is completed, your supervisor will check the quality of the finished work.

Exercises (017):

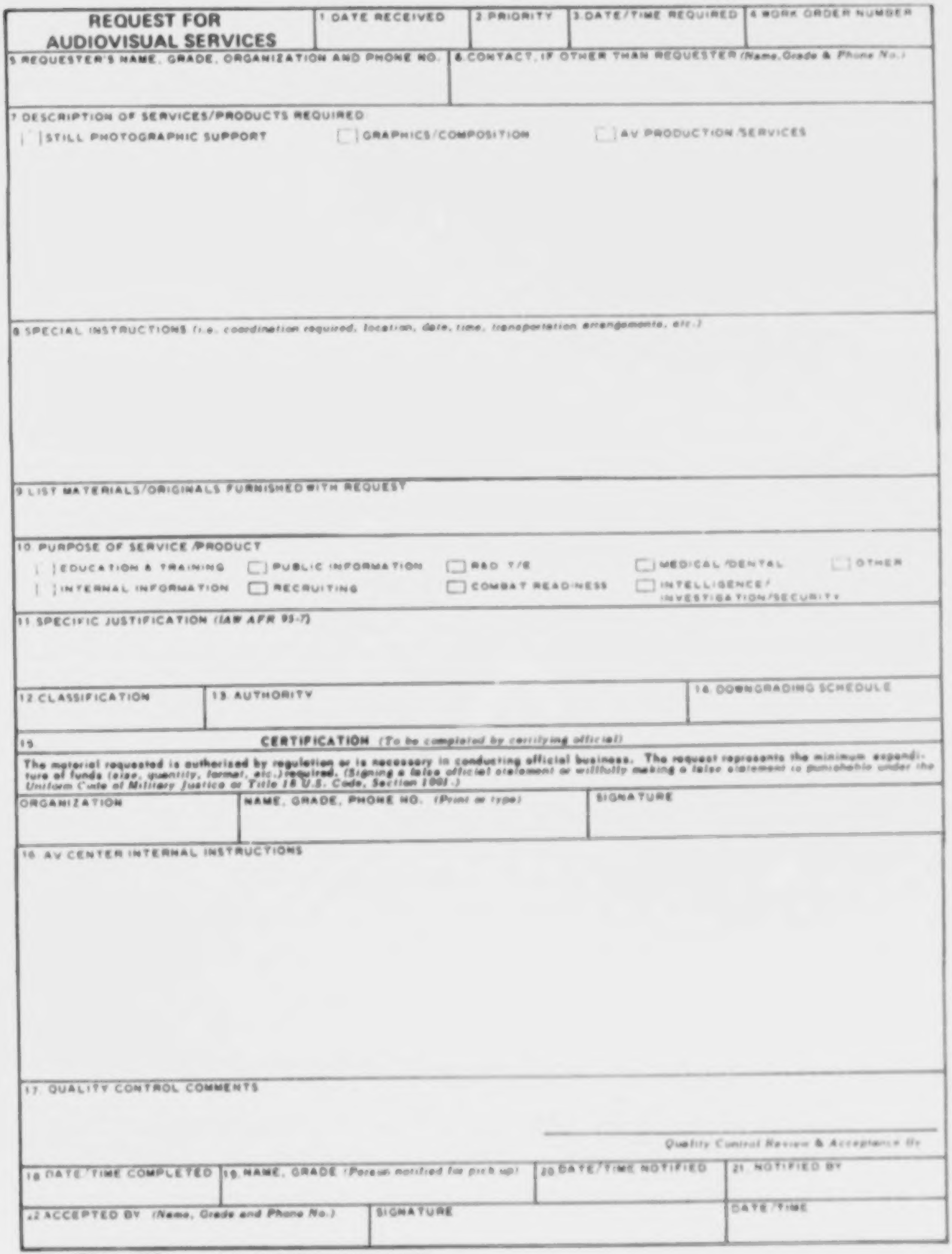
1. Why is it important to fill out the AF Form 833 properly?

2. Blocks 8 and 9 of AF Form 833 are completed by ________ .

3. The quality control part of AF Form 833 is accomplished by ________ .

018. State the purpose of a work request log and list the data that it should contain.

An optional form used by most photo labs is a work request log. A work request log may be in the form of a handwritten ledger or a locally produced form. The purpose of a work request log is to provide information to administrative lab personnel on all work requests received by the photo lab that are being worked on or



REQUEST FOR AUDIOVISUAL SERVICES
1. DATE RECEIVED
2. PRIORITY
3. DATE/TIME REQUIRED
4. WORK ORDER NUMBER
5. REQUESTER'S NAME, GRADE, ORGANIZATION AND PHONE NO.
6. CONTACT, IF OTHER THAN REQUESTER *(Name, Grade & Phone No.)*
7. DESCRIPTION OF SERVICES/PRODUCTS REQUIRED
☐ STILL PHOTOGRAPHIC SUPPORT ☐ GRAPHICS/COMPOSITION ☐ AV PRODUCTION/SERVICES
8. SPECIAL INSTRUCTIONS *(i.e. coordination required, location, date, time, transportation arrangements, etc.)*
9. LIST MATERIALS/ORIGINALS FURNISHED WITH REQUEST
10. PURPOSE OF SERVICE/PRODUCT
☐ EDUCATION & TRAINING ☐ PUBLIC INFORMATION ☐ R&D T/E ☐ MEDICAL/DENTAL ☐ OTHER
☐ INTERNAL INFORMATION ☐ RECRUITING ☐ COMBAT READINESS ☐ INTELLIGENCE/INVESTIGATION/SECURITY
11. SPECIFIC JUSTIFICATION *(IAW AFR 95-7)*
12. CLASSIFICATION
13. AUTHORITY
14. DOWNGRADING SCHEDULE
15. **CERTIFICATION** *(To be completed by certifying official)*
The material requested is authorized by regulation or is necessary in conducting official business. The request represents the minimum expenditure of funds (size, quantity, format, etc.) required. *(Signing a false official statement or willfully making a false statement is punishable under the Uniform Code of Military Justice or Title 18 U.S. Code, Section 1001.)*
ORGANIZATION
NAME, GRADE, PHONE NO. *(Print or type)*
SIGNATURE
16. AV CENTER INTERNAL INSTRUCTIONS
17. QUALITY CONTROL COMMENTS
Quality Control Review & Acceptance By
18. DATE/TIME COMPLETED
19. NAME, GRADE *(Person notified for pick up)*
20. DATE/TIME NOTIFIED
21. NOTIFIED BY
22. ACCEPTED BY *(Name, Grade and Phone No.)*
SIGNATURE
DATE/TIME

AF FORM AUG 88 833 PREVIOUS EDITION WILL BE USED

Figure 4-1. AF Form 833 (front).

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PRODUCTION DATA (To be completed by AV personnel)

STILL PHOTOGRAPHIC SUPPORT

PRODUCT SERVICE	B&W	COLOR	SIZE	QTY
General Photography Exp				
Portraiture Exp				
Copy Camera Exp				
Film Processing				
Negatives Slides Delivered				
Printing G. Matte				
Proofs				
Contact Prints				
Projection Prints				
Prints Delivered				
35mm Slides				
Lantern Slides				
Viewgraphs				
Filmstrips				
Other				
MOUNTING	▨	▨		

SLIDES ☐ Plastic ☐ Cardboard ☐ Glass

PRINTS ☐ Pebble Board ☐ Smooth Board

☐ White ☐ Black ☐ Gray

GRAPHICS/COMPOSITION

PRODUCT SERVICE	SIZE	ORIG UNITS
Camera Ready Art-Simple		
Camera Ready Art-Complex		
Cartoon Art		
Chart-Simple		
Chart-Complex		
Comprehensive Layout		
Drafting-Simple		
Drafting-Complex		
Exhibit/Display/Model		
Hand Lettering		
Headline Composition		
Illustration-Simple		
Illustration-Complex		
Mural Art		
Sign Art		
Silkscreen Art/Prod		
Text Composition		
Viewgraph Production		
Other		

AUDIOVISUAL PRODUCTION SERVICES

PRODUCT/SERVICE	Pr Min Units	DUPES
AV Production		
Motion Picture-16mm		
Motion Picture-8mm		
Slide Tape		
Audio Tape		
Television		
Multi-Media		
Other		
AV Services		
Audio Dubbing		
Video Dubbing		
Scripting		
Mopix Editing		
TV Editing		
Mopix Photography		
Still Photographs		
TV Recording		
Mopix Film Processing		
Other		

RESOURCE EXPENDITURE DATA

24

LABOR COST

TASK DESCRIPTION	PERFORMED BY	Reg Hours	O.T. Hours	Total Hours	Labor Cost
TOTAL WORK HOURS AND LABOR COST					

25

MATERIAL COST

ITEM DESCRIPTION	Units	Unit Cost	Item Cost	ITEM DESCRIPTION	Units	Unit Cost	Item Cost
SUBTOTAL				TOTAL MATERIAL COST			

26

SUPPLEMENTAL WORK ORDER AND/OR OTHER OUTSIDE COST

TASK OR SERVICE DESCRIPTION	FURNISHED BY	ORDER NO.	COST

27 DISPOSITION OF ORIGINAL MATERIAL ☐ RETURN TO CUSTOMER ☐ SUBMITTED IAW AFR 95-4 ☐ DESTROYED ☐ MASTER FILE ☐ SILVER RECOVERY ☐ OTHER	TOTAL OTHER COST	
	28 TOTAL PROJECT COST	

Figure 4-1A. AF Form 833 (back)

have been completed and filed. The work request log should have as a minimum the following entries: The request number, requestor's organization or office symbol, date received, description of the work and date completed. This log proves to be very helpful when cross-referenced to the work request and negative files. It provides quick location and status of all work requests being accomplished or already completed. Laboratory administrative personnel use the log to locate filed negatives and answer inquiries on the status of work requests.

Exercises (018):

1. What is the purpose of a work request log?

2. List three items of information that a work request log should contain.

3. How do photo lab administrative personnel use a work request log?

018a. (033—for CE feedback reference only). List information required on a production report.

Earlier we mentioned the importance of maintaining accurate production information on work requests. This information is totalled at the end of the month, and the accumulation of this information becomes the production report.

The production report includes all of the camera exposures and prints made in your lab during the month. It also includes all of the end products you delivered to your customers throughout the month. These end products are prints, slides, negatives, copies, etc., that your customers received.

The production report may be a locally produced form, but it must include the following:

- Outside exposures.
- Inside exposures.
- Copy camera exposures.
- Black & white negatives delivered.
- Color negatives delivered.
- Contact prints.
- Production prints.

Each of these units of work is assigned a weighted factor as described in AFM 26-3, Volume 3, *Mission Equipment Maintenance Operations*. After all of the work units have been counted and the weighted factors are totaled, the total is correlated with rules and tables in AFM 26-3. This correlation tells the manpower personnel how many people and what AFSC's are authorized to be assigned at your lab.

The primary purpose of keeping a production report is so that it will be available whenever the manning of your work center is evaluated. Evaluation of your work center manning is usually accomplished once yearly. A second purpose of keeping a production report is for the determination of the fiscal year operating budget. Without accurate records, the required manning and needed operational funds would be difficult to justify.

Exercises (018a):

1. What is the primary purpose of keeping production reports?

2. Where is the information obtained for the production report?

3. List items that must be included on your production report.

4-2. File Correspondence and Negatives

Documentation plays an important role in managing and operating the Air Force. It serves as the memory of your organization, a record of past events, and the basis for future decisions and actions. Documentation that is maintained systematically is complete, easily accessible, and properly arranged to serve current and future purposes. If documentation is properly located in your lab, it allows full use and it eliminates duplication.

019. List the steps you follow to find a letter in your file.

Suppose you wanted to find a letter that your lab chief wrote to the authors of this CDC. You know you must "Look in the files." That's fine, but which file, what drawer, and what file folder?

The first thing you need to find is the Air Force (AF) Form 80, Files Maintenance and Disposition Plan. A typical AF Form 80 is shown in figure 4-2. To find this form, look in the front of the first file drawer. When you have found the AF Form 80, study it until you find the type of correspondence you are looking for. In this case, "General Correspondence (Temporary)." You see that this is item number five. Under item five, you will find "Training." Under this heading you see "1-Correspondence." Now you know where to look.

Your next step is to look through the file drawer until you find the section identified "5-General Correspondence." Look behind this card until you find another card marked "TNG-TRAINING." Now look behind this card until you find the folder marked

"TNG-Correspondence." The last step is to look through the folder until you find the letter you need. This is made a bit simpler if you know about when the letter you need was written. The letters and documents in the folder are filed by date, the most recent in the front.

Quite simple isn't it? If you have trouble the first time you try, remember that the first time you try almost anything, you will have a little trouble.

Exercises (019):

1. List the steps you must follow in order to find a letter in your file.

020. State how files of negatives are kept.

All photographic laboratories are required to maintain a file of the negatives that they produce. Since the destruction or disposition of negatives and prints is not immediate in all cases, it is necessary to file certain negatives and prints in your laboratory. It may, at times, be necessary to reprint negatives. With an effective filing and indexing system, negatives can be located and reprinted as required. The file of negatives contains still or ground photography negatives. Filed negatives should not have a security classification higher than confidential. Both ground and individual aerial (except aerial reconnaissance and mapping) still negatives may be placed in this file.

Some of the negatives and photographs your lab produces are not considered to be file material. Except in unusual circumstances, the following examples should not be filed:

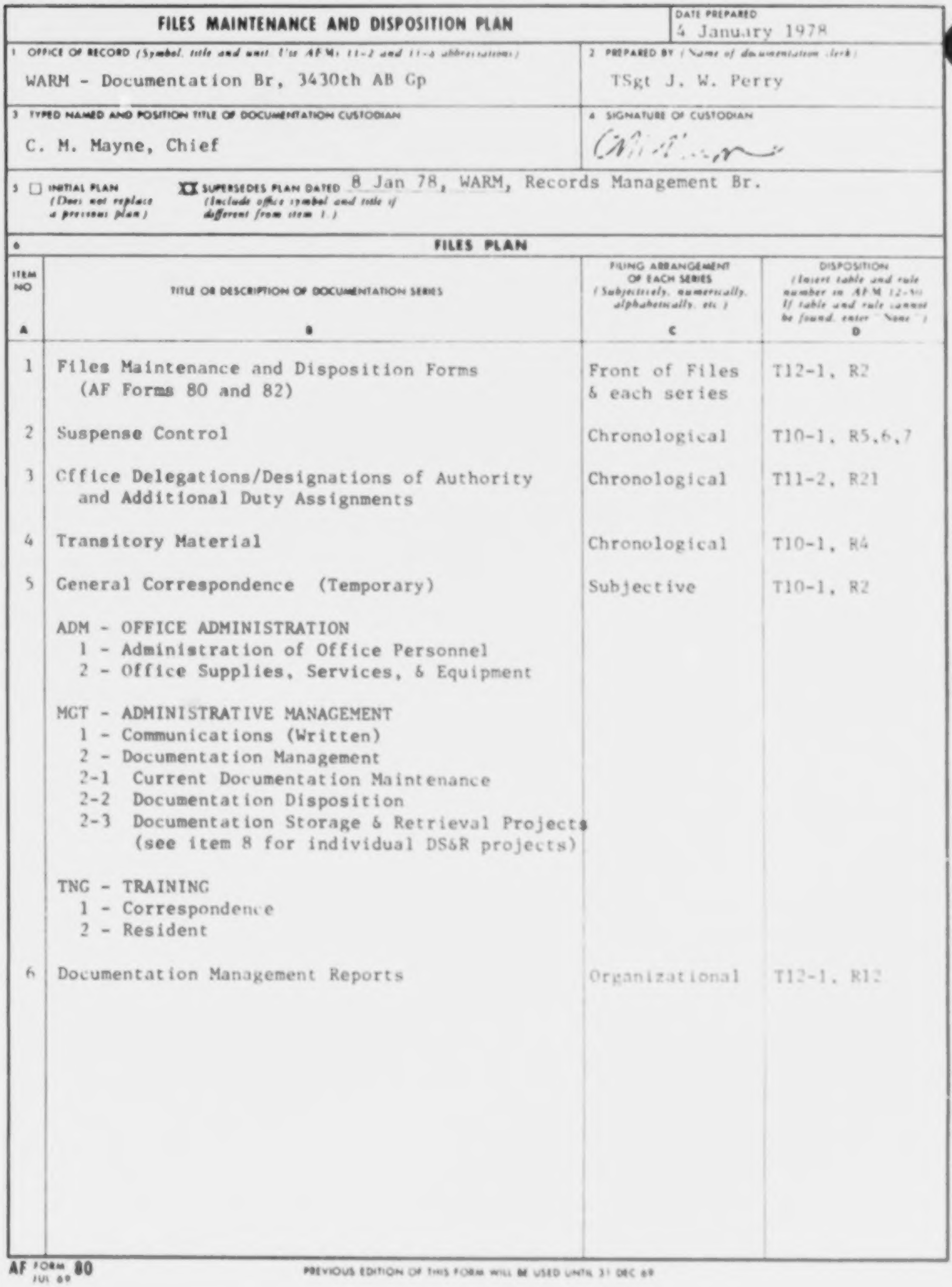
a. Photographs of no value for retention; i.e., copy negatives that satisfy the needs of one user, training assignments, and other photographs that satisfy a local one-time need such as recreation or nonhistorical events.

b. Photographs from which reproduction is not feasible because of improper focus, faulty processing, or color photographs in which color rendition is extremely poor.

There are no cut-and-dried rules for your negative files as there are for the correspondence files. However, AFM 12-50, *Disposition of Air Force Documentation*, does contain rules on what to file and how long to keep it.

For example, according to Table 95-1 in AFM 12-50, original negatives of purely local interest can be destroyed when their purpose has been served. You must file them until you destroy them.

Any negatives you produce for training or practice that are of subjects not desired for record are destroyed when their purpose has been served. If you shoot some pictures of the front doorknob just to practice, you



FILES MAINTENANCE AND DISPOSITION PLAN

DATE PREPARED 4 January 1978

1 OFFICE OF RECORD *(Symbol, title and unit. Use AFMs 11-2 and 11-4 abbreviations)*: WARM - Documentation Br, 3430th AB Gp

2 PREPARED BY *(Name of documentation clerk)*: TSgt J. W. Perry

3 TYPED NAMED AND POSITION TITLE OF DOCUMENTATION CUSTODIAN: C. M. Mayne, Chief

4 SIGNATURE OF CUSTODIAN:

5 ☐ INITIAL PLAN *(Does not replace a previous plan)* ☒ SUPERSEDES PLAN DATED *(Include office symbol and title if different from item 1.)* 8 Jan 78, WARM, Records Management Br.

6 **FILES PLAN**

ITEM NO A	TITLE OR DESCRIPTION OF DOCUMENTATION SERIES B	FILING ARRANGEMENT OF EACH SERIES *(Subjectively, numerically, alphabetically, etc.)* C	DISPOSITION *(Insert table and rule number in AFM 12-50. If table and rule cannot be found, enter "None")* D
1	Files Maintenance and Disposition Forms (AF Forms 80 and 82)	Front of Files & each series	T12-1, R2
2	Suspense Control	Chronological	T10-1, R5,6,7
3	Office Delegations/Designations of Authority and Additional Duty Assignments	Chronological	T11-2, R21
4	Transitory Material	Chronological	T10-1, R4
5	General Correspondence (Temporary)	Subjective	T10-1, R2
	ADM - OFFICE ADMINISTRATION 1 - Administration of Office Personnel 2 - Office Supplies, Services, & Equipment		
	MGT - ADMINISTRATIVE MANAGEMENT 1 - Communications (Written) 2 - Documentation Management 2-1 Current Documentation Maintenance 2-2 Documentation Disposition 2-3 Documentation Storage & Retrieval Projects (see item 8 for individual DS&R projects)		
	TNG - TRAINING 1 - Correspondence 2 - Resident		
6	Documentation Management Reports	Organizational	T12-1, R12

AF FORM 80 JUL 69 PREVIOUS EDITION OF THIS FORM WILL BE USED UNTIL 31 DEC 69

Figure 4-2. AF Form 80. Files Disposition Plan.

would not keep them in the negative file. However, if the doorknob had been broken and your pictures were used for a damage report, you must keep the negatives in your files for 90 days. You should read AFM 12-50, Table 95-1, to find out which negatives to file and how long to keep them.

The following information is not to be taken as a rule but is included as a suggestion for a negative filing system. A negative file ledger, sometimes referred to as a negative log, is a numerical record of each negative that is filed. When the number of a specific negative is known, referring to this device provides pertinent information concerning the negative. Another valuable indexing device is the card index file. The title of each negative is recorded on a card which is part of an alphabetical file. The card file should be cross-indexed so that the information appears under several letters of the alphabet. For example, in the first entry in the negative file ledger, the letters P-S are shown in the cross-index column. In this case, the P stands for passport and the S stands for the first letter of the last name of the subject.

Exercises (020):

1. Complete the following statements regarding the filing of negatives.
   a. The negative file contains still or ground photography negatives classified ____________ or lower.

   b. AFM ____________ contains rules on which negatives to file and how long to keep them.

   c. If you produce pictures for practice, you ____________ have to file them.

4-3. Publications

The Technical Order (TO) System. The technical order system is the official means used to distribute militay orders of a technical nature to all personnel. These publications, called technical orders (TOs), contain information, instructions, and safety procedures that deal with the inspection, operation, maintenance, and modification of Air Force equipment and material. Some TOs have instructions or information on subjects of a general nature such as preparation of forms, policies pertaining to the TO system, and how to handle Air Force material. In addition to TOs, you must be concerned with regulations, operating instructions (OIs), and commercial publications.

021. From a list of statements regarding the types of technical orders, select those that are true.

The technical order system was developed so that information will be available where and when it is needed and in the most economical and efficient manner possible. The groups of publications produced are described in the following paragraphs.

Technical Manual (TM). A TM contains instructions designed to meet the needs of personnel engaged or being trained to operate, service, maintain, overhaul, install, and inspect items of equipment and material.

Methods and Procedures Technical Order (MPTO). An MPTO establishes policy and provides information and instructions on safe methods and procedures that relate to preventive maintenance, periodic inspection, Air Force product improvement, etc.

Time Compliance Technical Order (TCTO). TOs that contain instructions for a modification or a one-time inspection of Air Force equipment are called time compliance technical orders.

Index Technical Orders. This kind of TO shows the status of all TOs, provides you with a way of selecting needed publications, and groups publications that pertain to specific items of equipment.

Abbreviated TO. This is primarily a work-simplification device, such as a checklist, inspection workcard, lubrication chart, or sequence chart.

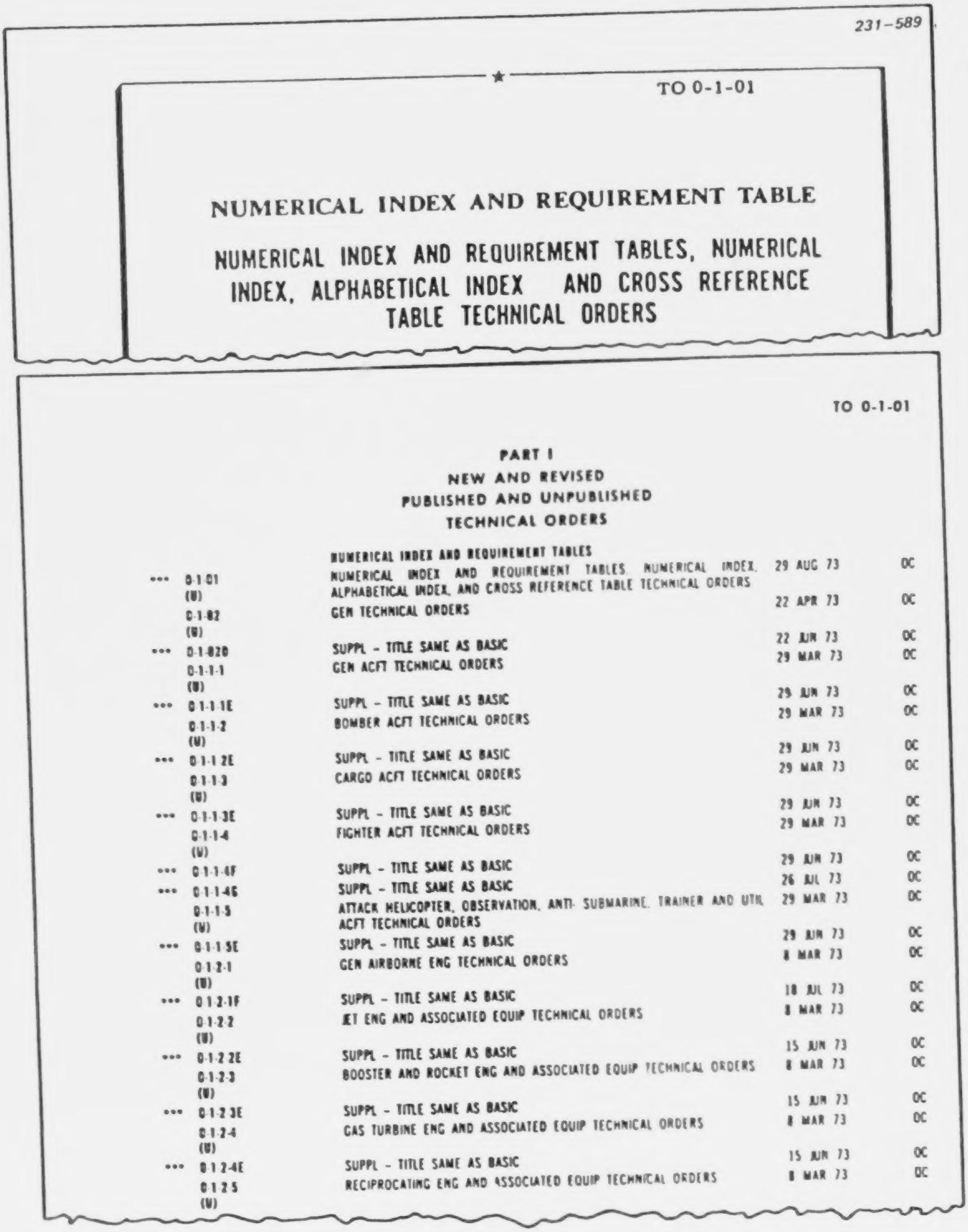
Exercise (021):

1. Read the following statements regarding types of technical orders and select the ones that are true.
   a. If you need to overhaul a camera, you should read the technical manual.
   b. An MPTO must be complied with in less than 30 days.
   c. TCTOs describe one-time modification procedures.
   d. An abbreviated TO lists all of the official Air Force abbreviations.

022. Find the technical order containing operating procedures for specific photographic equipment by referring to reproductions of selected pages from a TO index.

In your work you are concerned, to a large degree, with the technical manuals, since these publications contain detailed instructions and information required for the operation, maintenance, inspection, installation, overhaul, and identification of parts/components for the various types of photographic equipment. To use these manuals efficiently, you must know the indexing system.

Index-Type Technical Orders. This group of technical order publications (indexes) is an important item in your work. The problem of finding the technical manual you want can be solved by consulting the proper index. There are a number of indexes, but the one that you are most concerned with is the Numerical Index and Requirement Table (fig. 4-3) that



231-589

★

TO 0-1-01

NUMERICAL INDEX AND REQUIREMENT TABLE

NUMERICAL INDEX AND REQUIREMENT TABLES, NUMERICAL INDEX, ALPHABETICAL INDEX AND CROSS REFERENCE TABLE TECHNICAL ORDERS

TO 0-1-01

PART I
NEW AND REVISED
PUBLISHED AND UNPUBLISHED
TECHNICAL ORDERS

		NUMERICAL INDEX AND REQUIREMENT TABLES		
***	0-1-01 (U)	NUMERICAL INDEX AND REQUIREMENT TABLES, NUMERICAL INDEX, ALPHABETICAL INDEX, AND CROSS REFERENCE TABLE TECHNICAL ORDERS	29 AUG 73	OC
	0-1-02 (U)	GEN TECHNICAL ORDERS	22 APR 73	OC
***	0-1-02D	SUPPL - TITLE SAME AS BASIC	22 JUN 73	OC
	0-1-1-1 (U)	GEN ACFT TECHNICAL ORDERS	29 MAR 73	OC
***	0-1-1-1E	SUPPL - TITLE SAME AS BASIC	29 JUN 73	OC
	0-1-1-2 (U)	BOMBER ACFT TECHNICAL ORDERS	29 MAR 73	OC
***	0-1-1-2E	SUPPL - TITLE SAME AS BASIC	29 JUN 73	OC
	0-1-1-3 (U)	CARGO ACFT TECHNICAL ORDERS	29 MAR 73	OC
***	0-1-1-3E	SUPPL - TITLE SAME AS BASIC	29 JUN 73	OC
	0-1-1-4 (U)	FIGHTER ACFT TECHNICAL ORDERS	29 MAR 73	OC
***	0-1-1-4F	SUPPL - TITLE SAME AS BASIC	29 JUN 73	OC
***	0-1-1-4G	SUPPL - TITLE SAME AS BASIC	26 JUL 73	OC
	0-1-1-5 (U)	ATTACK HELICOPTER, OBSERVATION, ANTI- SUBMARINE, TRAINER AND UTIL ACFT TECHNICAL ORDERS	29 MAR 73	OC
***	0-1-1-5E	SUPPL - TITLE SAME AS BASIC	29 JUN 73	OC
	0-1-2-1 (U)	GEN AIRBORNE ENG TECHNICAL ORDERS	8 MAR 73	OC
***	0-1-2-1F	SUPPL - TITLE SAME AS BASIC	18 JUL 73	OC
	0-1-2-2 (U)	JET ENG AND ASSOCIATED EQUIP TECHNICAL ORDERS	8 MAR 73	OC
***	0-1-2-2E	SUPPL - TITLE SAME AS BASIC	15 JUN 73	OC
	0-1-2-3 (U)	BOOSTER AND ROCKET ENG AND ASSOCIATED EQUIP TECHNICAL ORDERS	8 MAR 73	OC
***	0-1-2-3E	SUPPL - TITLE SAME AS BASIC	15 JUN 73	OC
	0-1-2-4 (U)	GAS TURBINE ENG AND ASSOCIATED EQUIP TECHNICAL ORDERS	8 MAR 73	OC
***	0-1-2-4E	SUPPL - TITLE SAME AS BASIC	15 JUN 73	OC
	0-1-2-5 (U)	RECIPROCATING ENG AND ASSOCIATED EQUIP TECHNICAL ORDERS	8 MAR 73	OC

Figure 4 3. Numerical Index and Requirement Table.

contains a listing of all photographic equipment technical manuals.

You must first refer to a general index that lists all available indexes. The 0-1-01, *Numerical Index and Requirement Table,* is an index to indexes. It includes a listing of all numerical index and requirement tables, in addition to listing the *Alphabetical Index* (0-2-1) and the *Cross-Reference Tables* (0-4-1).

The *Cross-Reference Tables Index* (0-4-1) consists of a cross-reference table from former to new numbers for Air Force technical publications. It contains a complete listing of all technical orders affected by the renumbering program.

A numerical index and requirement table has been published for each specific category of equipment. Each contains a listing of applicable technical manuals for the pertinent equipment. These indexes bear technical order numbers 0-1-1-1, *General Aircraft and Missile Technical Orders,* through 0-1-50, *Special Service Equipment Technical Orders.* All photographic systems equipment technical manuals (TO 0-1-10, *Photographic Equipment, Supplies, and Sensitized Materials Technical Orders)* are listed in this index.

Each numerical index and requirement table not only provides a ready reference to existing publications (technical manuals) for the applicable category, but is also used to determine availability and status of applicable publications, to requisition applicable publications, and to maintain current technical publication files.

In addition to the numerical index, you may occasionally refer to the 0-2-1 which is an alphabetical index. The publications listed in this index are grouped under alphabetically arranged captions that indicate items of equipment by their basic or primary names. Thus, it provides an easy method for locating the correct technical order group when only the type of equipment is known.

Technical Order Numbering System. According to the basic principles of the technical order numbering system, all publications of a specific category are separated into primary (major) groups, usually by equipment. Except for certain general instructions, each major group is subdivided into major types (subgroups) of equipment and then into specific types and models of equipment. (The general series of each primary group is restricted to general instructions, such as cleaning or storage procedures.)

Keeping this in mind, let's see how a technical manual on photographic equipment is identified. Refer to figure 4-4 as you read the following paragraphs.

Material under the general heading of "Photographic Equipment, Supplies, and Sensitized Materials," has been grouped and numbered. Each technical order number for photographic systems technical manuals is divided into three or four parts, with each part separated by dashes. Each part of the technical order number denotes certain information. For example, the number for the illustrated parts breakdown of the Type KS-118A, Still Picture Camera Set is 10B1-8-9-1.

Note that there are four major parts in this TO number. The information contained in this number is as follows:

a. The number 10 identifies the technical order category, which, in this case, is: Photographic Equipment, Supplies, and Sensitized Materials Technical Orders.

b. The 10B indicates the major group of publications, specifically in this example, Ground Cameras and Equipment.

c. The 10B1 identifies a major subgroup of related publications: Ground Cameras.

d. The 10B1-8 identifies a specific item of the major subgroup; or if a three-part number were used, it would identify a general technical order series or an equipment type, part number, model, or series type. In this case, it identifies the camera in question as a copy camera.

e. The 10B1-8-9 indicates a general TO series or an equipment type, part number, or model or series number. If only three parts were used, this number would identify the individual publication. In this example, it identifies the KS-118A Copy Camera.

f. The final ~~term~~ digit (1) in the complete publication number, TO 10B2-8-9-1 denotes the specific kind of publication—whether it deals with operation and service instruction, overhaul instructions, etc. In this example, it represents the ~~illustrated parts breakdown (IPB)~~ operating instructions for the Type KS-118A, Copy Camera.

As you can see, each number of a technical order manual specifies a certain classification of equipment, and each letter or number must be carefully identified. The final part of each technical order number reflects the type of publication as follows:

Operating instructions: -1, -11, -21 through -491.
Service instructions: -2, -12, -22 through -492.
Illustrated parts breakdown: -4, -14, -24 through -494.
Inspecting requirements: -6, -16, -26 through -496.
Installation instructions: -7, -17, -27 through -497.
Checkout manuals: -8, -18, -28 through -498.
Time compliance technical orders: -501 and higher.

Using the Numerical Index, TO 0-1-10. As you now know, the first step in locating information about any item of photographic systems equipment is to consult TO 0-1-10, Photographic Equipment, Supplies, and Sensitized Materials Technical Orders. To use this index, the general procedure is to turn to the table of contents and locate the major group of publications you want. The actual number of major groups is as follows:

Major Group	*Title*
10A	Airborne Cameras and Equipment
10B	Ground Cameras and Equipment
10C	Motion Picture Cameras and Equipment
10D	Projection Equipment

Major Group	*Title*
10E	Processing Equipment
10F	Microfilm Equipment
10G	Kits, Photographic Equipment
10H	Interpretation and Photogrammetric Equipment
10J	Sensitized Materials and Supplies
10K	Radar Assessing Equipment
10L	Photographic Instrumentation Equipment
10M	Photographic Laboratories

Assume that you are looking for the technical manual that contains information and instruction on the operation of a standard item of Ground Cameras and Equipment. By counsulting the list of major groups, you can find the group in which this information can be found.

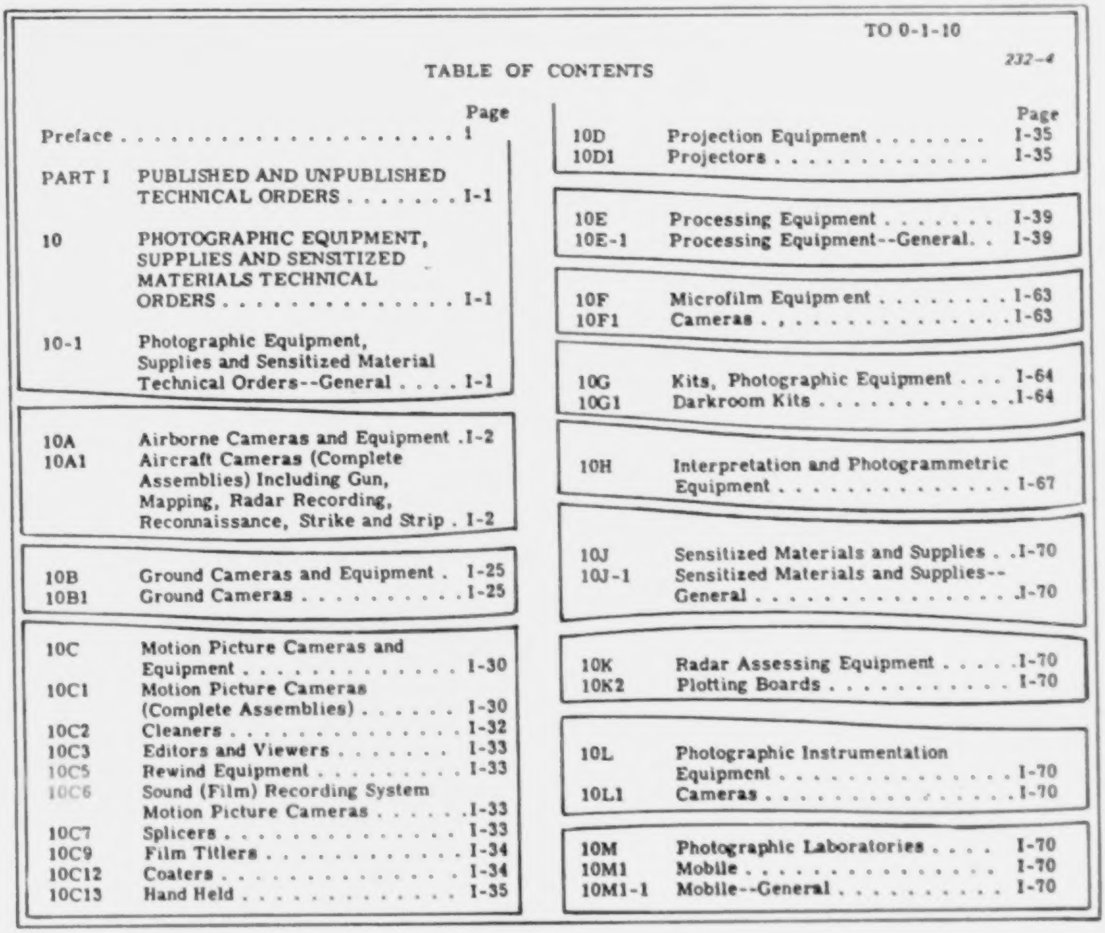
The next step in locating the technical order is to determine the correct subgroup of publications. In the table of contents in the 0-1-01 index (fig. 4-4), you will note that each of the major groups is broken down into subgroups.

Referring to the list of subgroups under Ground Cameras and Equipment in figure 4-4, you can find the first part of the desired technical order number and the page where this subgroup of technical orders can be found. Turn to this page (fig. 4-5), and look under the general heading until you find the specific type of equipment, in this case, Ground Cameras.

Next, assuming that more than one specific type of equipment (various manufacturers, models, etc.) are listed, select your specific type from those listed. Your selection identifies the next digit in your TO number.

The final step is to scan the general series until you locate the specific type. Usually, there are three types of technical manuals listed under each series: operation and maintenance instructions, overhaul instructions, and an illustrated parts breakdown.

Now you know the number of the technical manual you need, and you can obtain it from your technical order library.



TO 0-1-10

232-4

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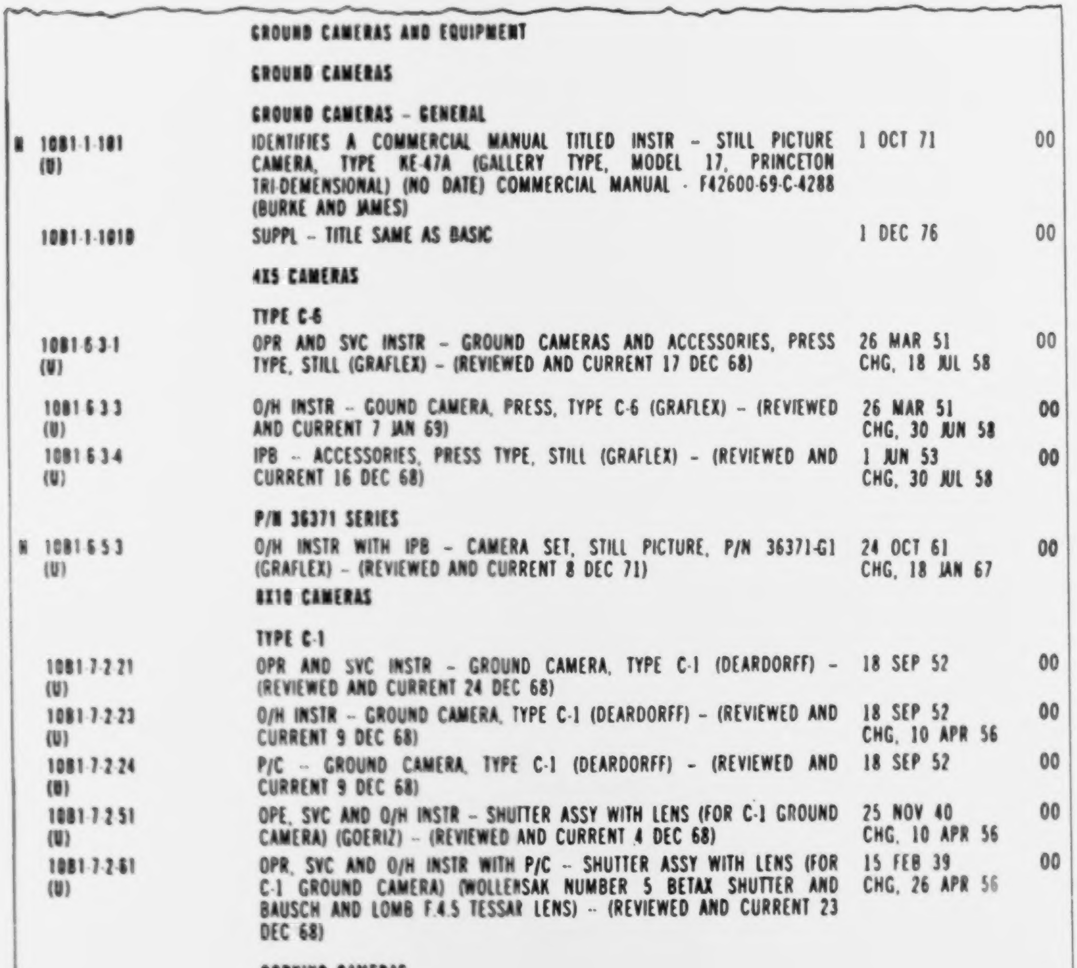
Figure 4-4. Major Groups and Subgroups.



	GROUND CAMERAS AND EQUIPMENT		
	GROUND CAMERAS		
	GROUND CAMERAS - GENERAL		
N 1081-1-101 (U)	IDENTIFIES A COMMERCIAL MANUAL TITLED INSTR - STILL PICTURE CAMERA, TYPE KE-47A (GALLERY TYPE, MODEL 17, PRINCETON TRI-DEMENSIONAL) (NO DATE) COMMERCIAL MANUAL - F42600-69-C-4288 (BURKE AND JAMES)	1 OCT 71	00
1081-1-101D	SUPPL - TITLE SAME AS BASIC	1 DEC 76	00
	4X5 CAMERAS		
	TYPE C-6		
1081-6-3-1 (U)	OPR AND SVC INSTR - GROUND CAMERAS AND ACCESSORIES, PRESS TYPE, STILL (GRAFLEX) - (REVIEWED AND CURRENT 17 DEC 68)	26 MAR 51 CHG, 18 JUL 58	00
1081-6-3-3 (U)	O/H INSTR - GOUND CAMERA, PRESS, TYPE C-6 (GRAFLEX) - (REVIEWED AND CURRENT 7 JAN 69)	26 MAR 51 CHG, 30 JUN 58	00
1081-6-3-4 (U)	IPB - ACCESSORIES, PRESS TYPE, STILL (GRAFLEX) - (REVIEWED AND CURRENT 16 DEC 68)	1 JUN 53 CHG, 30 JUL 58	00
	P/N 36371 SERIES		
N 1081-6-5-3 (U)	O/H INSTR WITH IPB - CAMERA SET, STILL PICTURE, P/N 36371-G1 (GRAFLEX) - (REVIEWED AND CURRENT 8 DEC 71)	24 OCT 61 CHG, 18 JAN 67	00
	8X10 CAMERAS		
	TYPE C-1		
1081-7-2-21 (U)	OPR AND SVC INSTR - GROUND CAMERA, TYPE C-1 (DEARDORFF) - (REVIEWED AND CURRENT 24 DEC 68)	18 SEP 52	00
1081-7-2-23 (U)	O/H INSTR - GROUND CAMERA, TYPE C-1 (DEARDORFF) - (REVIEWED AND CURRENT 9 DEC 68)	18 SEP 52 CHG, 10 APR 56	00
1081-7-2-24 (U)	P/C - GROUND CAMERA, TYPE C-1 (DEARDORFF) - (REVIEWED AND CURRENT 9 DEC 68)	18 SEP 52	00
1081-7-2-51 (U)	OPE, SVC AND O/H INSTR - SHUTTER ASSY WITH LENS (FOR C-1 GROUND CAMERA) (GOERIZ) - (REVIEWED AND CURRENT 4 DEC 68)	25 NOV 40 CHG, 10 APR 56	00
1081-7-2-61 (U)	OPR, SVC AND O/H INSTR WITH P/C - SHUTTER ASSY WITH LENS (FOR C-1 GROUND CAMERA) (WOLLENSAK NUMBER 5 BETAX SHUTTER AND BAUSCH AND LOMB F.4.5 TESSAR LENS) - (REVIEWED AND CURRENT 23 DEC 68)	15 FEB 39 CHG, 26 APR 56	00
	COPYING CAMERAS		
	P/N SFS-35		
1081-8-8-1 (U)	INSTR WITH P/B - CAMERA, COPYING PHOTO STILL PICTURE CAMERA, P/N 01-1392, MODEL SFS-35 (SICKLES	15 JUL 68 CHG, 1 NOV 69	00
	P/N 12A5000-1		
1081-8-9-1 (U)	OPR AND SVC INSTR WITH IPB - STILL PICTURE CAMERA SET, TYPE KS-118A, P/N 12A5000-1 ASSY, P/N 12RA5000-1 (GENERAL DYNAMICS)	15 SEP 72	00
	MODEL KE-62A		
1081-8-10-11 (U)	INSTR WITH P/B - COPYING PHOTO STILL PICTURE CAMERA, P/N 6720-127-5791, MODEL KE-62A (SCKLES)	30 AUG 74	00
	IDENTIFICATION CAMERAS		

Figure 4-5. Sample Numerical Index.

It is doubtful that you will becomme an expert on the technical order numbering system merely by reading the foregoing information. But if you combine the information you learned here with the actual practice of searching out technical manuals for specific items of equipment, becoming an expert will be a much easier process.

Exercise (022):

1. Using figures 4-3, 4-4, and 4-5, answer the following questions.

   a. What is the TO number for a Type C–6, 4 x 5 camera?

   b. What is the TO number for a Type C–1, 8 x 10 Ground Camera?

   c. What piece of equipment is covered by TO 10B1–8–8–1?

   d. What piece of equipment is covered by TO 10B1–6–3–3?

023. State the purpose and identify the form of Air Force regualtions, operating instructions, and commercial texts.

Regulations. In anything you do, you must follow certain rules. You might be driving your car, playing golf, or typing a letter. The point is, there are always rules for you to follow. Air Force life is no different.

The purpose of Air Force regulations should be obvious; to insure each job is done *properly* and *uniformly*. You wouldn't want Boston Gardens to have a basketball court twice as long as the one in McNichols Stadium. Likewise, you wouldn't want the photo lab at Lowry to make official portraits on cardboard and the lab at Offutt to use glass.

Regulations are the primary administrative publications that govern the Air Force. They outline *policies*, *directives*, and *instructions*.

Identification of regulations is accomplished by a double numbering system. They follow a fixed numbering system which classifies them according to subject matter. A few examples are:

0 Series—Indexes
5 Series—Publication Management
50 Series—Training
95 Series—Audiovisual System

The regulation for Airman Basic Military Training is AFR 50–42. The 50 is the base number and the 42 is the subnumber. The series you will be most concerned with is the 95 series. Nearly everything you want to know about the audiovisual systems is covered in some regulation that is in the 95 series.

Operating Instructions. Sometimes regulations are not specific enough to cover a task. If this is the case, you may have to use an operating instruction (OI). These instructions are essential for several reasons.

First, they identify every task to be performed in the laboratory. Second, they explain the reasons for performing the task. Third, they place the responsibility for the performance of the task. Fourth, they outline the complete procedure to be followed to perform the task. Finally, they identify the authority for ordering the task.

The format for OIs is not rigid. It should be uniform throughout your operation, but it need not be the same as that used by other organizations. Regardless of the particular format, your OI should include the following:

a. Heading, including OI number and date.
b. Subject.
c. Purpose.
d. Responsibility.
e. Abstract.
f. References (if appoicable).
g. Procedure (step-by-step).
h. Signature element (including approval of interested officials).

Operating instructions are valuable management tools. They expand upon the duties, tasks, and responsibilities outlined in the regulations that govern them. They are most often prepared by responsible and knowledgeable personnel at the level of command where they will be used. In the case of an Audiovisual Services Center, these individuals are the photo lab, graphics section, and audiovisual library managers. These operating instructions are then reviewed and approved by the next higher level of command before they are published.

Commercial Publications. Commercial technical publications comprise another group of technical manuals that you will be required to use frequently. As with the other technical manuals, commercial publications contain technical information and instructions on assembly, installation, operation, service, disassembly, overhaul, and parts identification. Commercial publications in manual, booklet, or pamphlet form are normally furnished by manufacturers to purchasers of their product.

When you buy a car, you check the owner's manual carefully to insure proper operation under all conditions. It would be foolish to think that all cars are the same. This also applies to photo equipment. All cameras might have a shutter, lens, and focusing mechanism; but how the shutter is set, how a lens is changed or a camera is focused may vary considerably. Failure to follow directions can result in damaged equipment and mission failure. By reviewing your manuals, you can avoid these results.

Commercial texts are not used just to prevent trouble, but are positive aids to help you achieve efficient use of the gear. In fact, some manuals amount to a basic photo course because the manufacturer wants the user to get the most from his product. You should take advantage of the wealth of free information that is available. Moreover, all of the photo manufacturers have technical representatives who may be contacted for information on how to solve many photo problems.

Information is also available on expendable types of supplies. This information may not be in the form of a technical manual. Instead, it may simply be a single-page bulletin. A photographer should constinuously check such information to insure that he is taking advantage of changes in film and chemistry. For example, most instruction sheets that come with a roll of film give helpful hints on exposure and processing to insure top results. Such an information sheet belongs with you and not in the wastebasket.

Exercise (023):

1. Complete the following statements by filling in the missing term or phrase.

   a. The purpose of a regulation is to insure that each job is done __________ and __________.

   b. Regulations outline policies, directives, and __________.

   c. The series of regulations that deal with audiovisual systems is the __________ series.

   d. If the regulation is not specific enough, you may need to use a (an) __________ __________.

   e. OIs identify every __________ that is to be performed in your lab.

   f. Commercial publications are normally furnished by the __________.

   g. A commercial publication may be in the form of a single-page __________.

4-4. Audiovisual Records Disposition

Record photography is photography of significant mission and support activities of current or historical value to the Air Force.

Of course, not all photography that you produce qualifies as record photography. Many of your assignments will be routine in nature—passport and special assignment photographs, and transparencies for training and briefings are a few examples of nonrecord photography. It is important that you be able to distinguish between record and nonrecord photography.

024. From a list of photographic assignments, select those that should be considered record photography.

What distinguishes record photography from nonrecord photography? The determination is often subjective. Generally speaking, any photography of significant value should be retained. AFR 95-3, *Audiovisual Documentation Program,* is the best guide to use in making this determination. The following list of categories of assignments that are considered to be record photography is extracted from AFR 95-3:

(1) Combat and combat support activities, test.

(2) Air Force events of immediate news value, for example, new aircraft or equipment, rescues, record flights, major awards, and significant events.

(3) Events or actions of national or international news interest in which the Air Force is taking part.

(4) Changes in mission or equipment, such as base closures, new aircraft or units assigned to a base, base openings or expansions.

(5) Operational exercises and special projects.

(6) Research and development activities, for example, first flights, roll-outs, missile launches, continuing development photography of new inventory material.

(7) Safety, such as aircraft accidents, accident prevention programs.

(8) Counterinsurgency training and operation.

(9) Community relations humanitarian and civil actions, for example, flood relief, fire fighting, emergency blood donors, and aid to underpriviledged children.

(10) Air Force personnel at work (all aspects), such as flight-line crews, weather and radar men, training, medical, and religious activity.

(11) Special training activity, such as fire fighting, escape and evasion, paramedic, survival.

(12) Physical plant (once for record, then after any major changes, such as new construction).

(13) Physically handicapped persons working for the US Air Force.

(14) Distinguished awards and decorations for personnel.

(15) Air Force Academy, flight training and officer training activities.

(16) Unusual hobbies and duties of Air Force personnel.

(17) Reserve, ANG, ROTC, and CAP significant activities, such as search and rescue missions, humanitarian actions, disaster relief, etc.

(18) Athletic contests of more than local interest, such as interservice and intraservice tournaments end-of-season final games.

(19) Audiovisual material with unusual pictorial merit, for example, photography of equipment, people, or activities taken with unusual lighting or from an unusual angle.

(20) Audiovisual coverage of Air Force aircraft, missiles, and other equipment, taken from all angles, both in the air and on the ground.

(21) Color transparencies of artists' concepts of new aircraft, weapon systems, etc.

Nonrecord photography is usually any photography that does not fall within the above-mentioned categories. Also, negatives and prints of the above subjects that are of inferior quality, repetitious documentation of the same subject, and extra copies of photographs already submitted to still depositories are nonrecord photography. Another example of nonrecord photography is that of photographs used by the base information office which are of purely local interest. Still photography that has been selected for submission to USAF still depositories is record photography; any items not selected are nonrecord photography.

Exercise (024):

1. From the following list of photographic assignments, select those that should be considered record photography:
   a. Photographs of a new radar system being installed on the base.
   b. Photographs of a damaged supply shipment.
   c. Photographs of base firefighting personnel assisting the local fire department in putting out a large fire in the community.
   d. A passport photograph of an airman going overseas.
   e. A visit to your base by the Secretary of the Air Force.

4-5. Lettering and Captioning of Still Photography

All record materials produced by your laboratory must be identified to insure proper coordination of negatives and prints covering a wide variety of subjects that are forwarded to USAF still depositories from installations all over the world. Without proper identification, materials forwarded would be useless and, therefore, not acceptable as record photography.

025. State how to letter negatives.

Once materials have been selected for forwarding to USAF still depositories they must be lettered. AFR 95-4, *Audiovisual Records Disposition Program*, is your guideline for lettering and captioning still photography. Negatives must be lettered in the widest clear margin of exposed original materials. Letter with indelible ink on the acetate (base) side of the negative. Starting from the left, record the following information: negative number, claendar year, exposing unit, and security classification of the material. Never letter in an important part of any negative. When there is not enough room on the negative, attach a titling (acetate) strip to the negative. The negative number that you record is a locally assigned number. These numbers are in sequence starting with the number one on the first day of the calendar year. Example:

Number	*Year*	*Unit*	*Security*
1	78	1350 ABGp	CONFIDENTIAL

Negatives that are part of a sequential roll are identified by adding an alpha suffix to the negative number; 1a, 1b, etc.

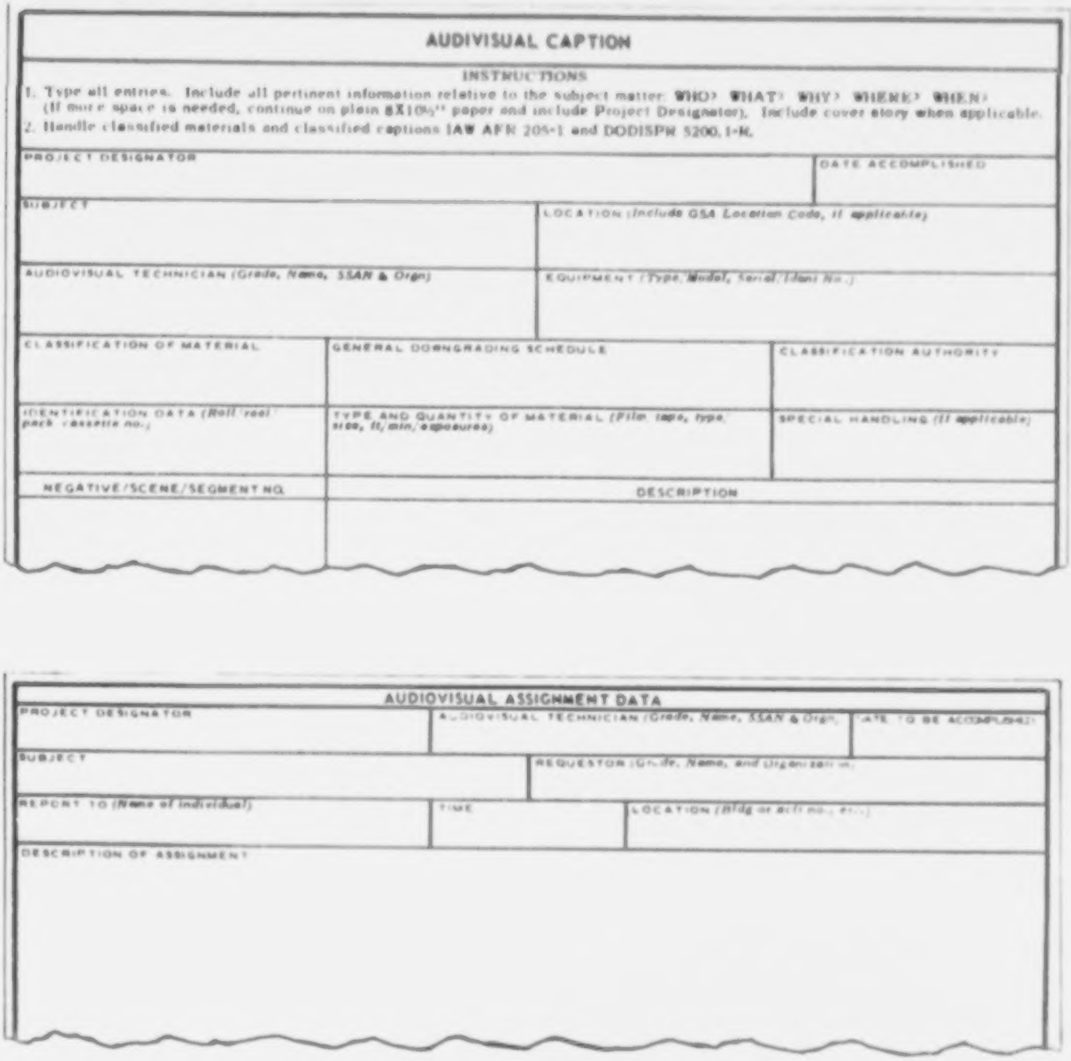
Exercise (025):

1. Complete the following statements.
   a. The negative identification number is __________ assigned.
   b. Lettering is done on the __________ side of the negative.
   c. When negatives from a sequential roll are lettered, an __________ is added to the negative number.
   d. Starting from the left, record this information: __________ __________, __________ __________, __________ __________, and __________ __________ of the material.

026. From a list of statements regarding captioning and identifying prints, select those that are true.

Lettering the negatives is just the first step in identifying record still photography. Captions for each photograph must be made and all prints released must be identified on the back of the print.

Each negative of record photography must be captioned. Captions are recorded on AF Form 397, Audiovisual Caption (fig. 4-6), for a series of photographs about the same subject or AF Form 398, Photographic Assignment Data, (fig. 4-7) (for an individual negative). These are the only forms that can be used to record captions. The AF Form 398 is very useful because it can be initiated to record assignment data before the assignment is photographed. To



AUDIVISUAL CAPTION

INSTRUCTIONS

1. Type all entries. Include all pertinent information relative to the subject matter: WHO? WHAT? WHY? WHERE? WHEN? (If more space is needed, continue on plain 8X10½" paper and include Project Designator). Include cover story when applicable.
2. Handle classified materials and classified captions IAW AFR 205-1 and DODISPR 5200.1-R.

PROJECT DESIGNATOR

DATE ACCOMPLISHED

SUBJECT

LOCATION (Include GSA Location Code, if applicable)

AUDIOVISUAL TECHNICIAN (Grade, Name, SSAN & Orgn)

EQUIPMENT (Type/Model, Serial/Ident No.)

CLASSIFICATION OF MATERIAL

GENERAL DOWNGRADING SCHEDULE

CLASSIFICATION AUTHORITY

IDENTIFICATION DATA (Roll/reel/pack/cassette no.)

TYPE AND QUANTITY OF MATERIAL (Film, tape, type, size, ft/min/exposures)

SPECIAL HANDLING (If applicable)

NEGATIVE/SCENE/SEGMENT NO.

DESCRIPTION

AUDIOVISUAL ASSIGNMENT DATA

PROJECT DESIGNATOR

AUDIOVISUAL TECHNICIAN (Grade, Name, SSAN & Orgn)

DATE TO BE ACCOMPLISHED

SUBJECT

REQUESTOR (Grade, Name, and Organization)

REPORT TO (Name of individual)

TIME

LOCATION (Bldg or rm no., etc.)

DESCRIPTION OF ASSIGNMENT

Figure 4-6. AF Form 397, Audiovisual Caption.

caption a photograph on the AF Form 398, fill in all spaces following the instructions printed on the form.

The photographic prints produced from record negatives must also be identified. As a minimum, the following data must be included on the back of each print:

a. OFFICIAL US AIR FORCE PHOTO
b. Exposing Organization
c. Identification Number
d. Security Classification

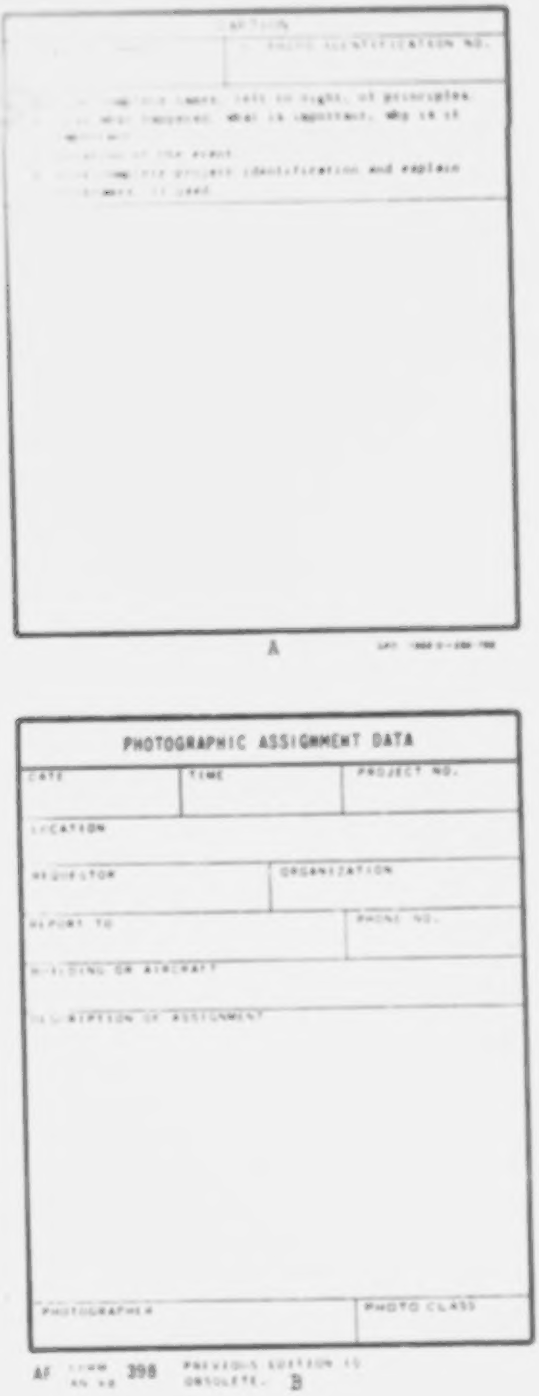
This information may be printed but the best method to use is ink stamping. The information on the back of the print should conform to the following example:

OFFICIAL US AIR FORCE PHOTO
1369 Photo Sq (AAVS) (MAC)
1-78-1369PS (Unclas)

Exercise (026):

1. Of the following statements, select those that are true.

___ a. Captions are written on the back of each print.
___ b. The instructions for completing captions are printed on AF Form 398.
___ c. AF Form 398 is the only form that can be used to record captions.
___ d. The best method to use when identifying prints is ink stamping.



CAPTION

PHOTO IDENTIFICATION NO.

A

PHOTOGRAPHIC ASSIGNMENT DATA		
DATE	TIME	PROJECT NO.
LOCATION		
REQUESTOR	ORGANIZATION	
REPORT TO	PHONE NO.	
BUILDING OR AIRCRAFT		
DESCRIPTION OF ASSIGNMENT		
PHOTOGRAPHER	PHOTO CLASS	

AF FORM 398 PREVIOUS EDITION IS OBSOLETE.

B

Figure 4-7. AF Form 398, Photographic Assignment Data

4-6. Disposition of Record Photography

Still record photography is submitted to the USAF Central Still Photographic Laboratory on a quarterly basis. Submission date is the last working day of each ending quarter. When no record pohotography has been accomplished by your lab during a quarter, then a negative report is required.

027. State how still record photography is transmitted.

Each separate submission must include three things: the original negative or negatives of the assignment, each properly lettered IAW AFR 95-4; captions (AF Form 397 or 398); and a high quality 4- x 5-inch (10 x 12 cm) print of each negative. If you are submitting negatives that are larger than 4 x 5 inches, then you should submit a contact (same size) print.

Each original negative is placed in a separate protective envelope along with the caption. For a series of photographs of the same subject, captions are placed on AF Form 397 to accompany the negatives. These are the basic procedures to use. For detailed instructions and special instructions on submitting items such as transparencies and 35mm negatives, refer to AFR 95-4.

Exercises (027):

1. The three items that make up a package for submission to the USAF Central Still Photographic Depository are ________, ________, and ________.

2. A ________ print should be submitted when negatives are larger than 4 x 5 inches (10 x 12 cm).

4-7. Copyright and Reproduction

The laws protecting photographs are numerous and involved. The most important regulations are the copyright laws which are promulgated by the Federal Government. A basic understanding of the copyright laws that affect reproductionof photographs and other materials is important to every Air Force photographer. Also, there are Federal and Air Force regulations which, in addition to the copyright laws, prohibit the reproduction of certain materials. All personnel in a photographic laboratory must concern themselves with the copyright laws and Air Force regulations governing copyrights. To reproduce copyrighted material without specific written release from the holder of the copyright is not permissible.

028. State whether, according to the copyright laws, certain subjects may be copied, and give other details of the copyright laws.

The most common areas in a photographic laboratory concerned with copyright restrictions are the administrative and reproduction sections. Your lab will receive numerous work requests to reproduce photographs, publications, and artwork for operational and training purposes. Occasionally, materials to be reproduced are copyrighted. Copyrighted materials are usually marked with the symbol © and are accompanied by the name of the company or person holding the copyright. When you handle work requests for reproduction, it is your responsibility to check all materials to be reproduced to insure that none of them are copyrighted.

Rights. A photographer has a property right to the photographs in his possession. In addition, the photographer may take steps to protect the artistic skill and mental effort that he applied to produce an original photographic idea. This additional protection, the one most violated, is called a copyright.

Article 1, Section 8, of the United States Constitution empowers Congress to "promote the progress of science and the useful arts, by securing for limited times to authors and inventors the exclusive right to their respective writings and discoveries." (The term "writings" has been construed to include photographs.) Under this Constitutional mandate, the Copyright Statute was enacted. The Copyright Act specifically prohibits the use, without permission, of a person's mental labors.

A photographer's work can be protected by three separate copyright laws; i.e., common law copyright, statutory copyright, and international copyright law. The common law (nonstatutory law) protects any unpublished photograph. The photographer does not have to file for this protection. The statutory copyright preserves the photographer's rights in pictures that he publishes. The copyright must be obtained through appropriate application with the Federal Government because States do not have the power to grant copyright protection. An international copyright that protects the photographer's works when published in certain foreign countries may be obtained.

The point to remember in regard to the publication of photographs is that the owner of the picture has certain personal rights which are specifically protected under the law. When you need to use another person's photographs, you must get written permission to use them. The owner of the photograph has the following rights:

- The right to forbid copying of the photograph.
- The right to sell the photograph outright.
- The right to sell particular use of the photograph.
- The right to forbid exhibition of the photograph.
- The right to sue in civil courts if any unauthorized use of the photograph is made.

In addition to facing a civil damage suit, a copyright infringer may also be criminally prosecuted, which may lead to imprisonment and paying of fines.

The thrust of the copyright laws is reaffirmed by Air Force regulations. The regulations clearly state that no person of the United States Air Force shall adopt or use or shall authorize the adoption or use for or on behalf of the Government or Air Force:

a. Any article, when it is known to be proprietary (privately owned).

b. Any matter in which it is known, or there is reason to believe, a copyright exists unless consent of the owner has been obtained or authorization has been given by the Air Force.

In addition to restrictions placed upon the reproduction of copyrighted material, the Federal and State Governments restrict the copying and reproduction of many other documents. Attachment 2 of AFR 6-1, *Policies, Procedures and Standards Governing Air Force Printing, Duplicating, Copying and Microform,* lists many of the items that you cannot reproduce or copy. The following is an excerpt from the regulation:

> Unlawful Reproduction
>
> (1) Reproduction of any of the following materials is unlawful unless authorized under regulations pursuant to law or excepted by paragraph (2) below:
>
> a. Adjusted compensation certificates for veterans of the World War.
> b. Automobile licenses, drivers' licenses, and automobile titles in certain states.
> c. Certificates of citizenship or naturalization.
> d. Certification of war necessity.
> e. Immigration papers.
> f. Licenses issued to marine officers.
> g. Obligations of any foreign government, bank, or corporation.
> h. Obligations or securities of the United States Government, including: Bonds, Certificates of Indebtedness, National Bank Currency, Coupons, United States Notes; Treasury Notes, Gold Certificates, Silver Certificates, Fractional Notes, Certificates of Deposit, bills, checks, or drafts for money, drawn by or upon authorized officers of the United States; Passports, Selective Service Registration Certificates.
> i. Official badges, identification cards, and other insignia of the design prescribed by the head of any department or agency of the US Government.
>
> (2) Exceptions: Printed illustrations of paper money, checks, bonds, and other obligations and securities of the United States and foreign governments are permissible for numismatic (coin collecting), educational, historical, and newsworthy purposes. The illustrations must be in black and white and must be of a size less than 3/4ths or more than 1½ times the size of the genuine instrument. The illustrations must appear in articles, books, journals, newspapers, magazines, or albums. No individual facsimiles are permitted. Printed illustrations of United States postage stamps are permissible for philatelic (stamp collecting), educational, historical, and newsworthy purposes in articles, books, journals, newspapers, or albums. The illustrations will be in black and white and may be the exact size of a genuine stamp. Colored illustrations are prohibited. United States revenue stamps may be illustrated under the same conditions and for the same purposes as illustrations of United States postage stamps. Printed illustrations and photographs of coins of the United States and foreign countries are permissible for any purposes including advertising. Token, disks or devices in the likeness or similitude as to the design, color, or the inspection thereon of the coins of the United States or of any foreign country are prohibited.

Finally, the making of indecent or obscene photographs or the possession of them is a court-martial offense as being scandalous conduct or conduct to the prejudice of good order and discipline. The photographing, copying, or reproduction of any such material is punishable by court-martial with penalties up to $5,000 or 5 years imprisonment, or both.

In your situation as an Airman working as a photographer for the United States Air Force, what you photograph on the job is not your property. This rule applies whether or not you use personal photographic equipment to cover official assignments. The following paragraph extracted from AFR 95-1, *USAF Audiovisual Resources and Functions*, outlines this policy:

> All audiovisual materials produced or collected by Air Force members or employees in the course of their official duties become the property of the Department of the Air Force. Personal use of such audiovisual material for sale or any other reason not directly related to an official Air Force activity is prohibited without the specific written approval of an official so authorized by law, regulation, orders, or other competent authority.
>
> Air Force members or employees, by choice or agreement, occasionally use personally owned equipment or supplies in the course of their official duties. However, this policy on personal use of audiovisual material applies regardless of whether personally owned equipment and supplies or Government resources are used to obtain or reproduce the material.

Finally, if copyrighted material is to be reproduced, a copyright release must be obtained from the holder of the copyright. It is the responsibility of the requester to obtain the copyright release. AFR 110-8, *Inventions, Patents, Copyright, and Trademarks*, outlines the procedures to be followed in obtaining a copyright release. The release must accompany the material to be reproduced and should be placed in laboratory files after the work has been accomplished.

Exercises (028):

1. Which of the following subjects can be legally copied?
   a. Immigration papers.
   b. United States Bonds.
   c. Passports.
   d. Selective Service Registration Certificates.
   e. One dollar bill copies 150 percent in black and white.
   f. Color picture of an 8¢ stamp.
   g. Black and white picture of a revenue stamp.
   h. Color photograph of a dim
   i. Identification badge.
   j. Mexican dollar for numismatic purposes.

2. Complete the following statements regarding the copyright laws.
   a. The purpose of the copyright laws is to protect the photographer's ____________ labors.
   b. The copyright laws are controlled by the ____________ Government.
   c. The copyright laws have been reaffirmed by Air Force ____________.
   d. The common law protects any ____________ photograph.
   e. As a copyright infringer, you may face ____________ damages and ____________ prosecution.

4-8. Equipment Responsibility

When you buy an article from a store, the moment the sales clerk completes the transaction, the store drops its accountability. The article then becomes your property and responsibility. You alone are accountable for it and you can do with it whatever you please.

Similarly, whenever a supply person issues an Air Force item to you, accountability for this item is dropped as far as the issuing authority is concerned. However, you do not become the owner of the item. Instead, the Air Force retains ownership and you assume responsibility for the care and protection of the item.

029. State the purpose of a DD Form 362, Statement of Charges, and DD Form 200, Report of Survey.

Pecuniary Liability. Personnel who are responsible for public property as defined in AFR 67-10, *Responsibility for Management of Public Property in Possession of the Air Force*, are also pecuniarily liable. Pecuniary liability means that anyone in the Air Force can be made liable to pay for loss, damage, or destruction of property which was a result of maladministration or negligence in the use, care, custody, or safeguarding of such property.

When an item is lost, damaged, or destroyed, one of two actions can occur.

Admission of Negligence. When pecuniary liability is admitted, the least troublesome way to settle the obligation is to pay for the item in cash. A DD Form 1131, Cash Collection Voucher, is made up to show the amount of money paid, a complete description of the item(s) involved, and the purpose for which the collection is being made. If you admit liability but don't have the cash to pay for the item that was lost or damaged, DD Form 362, Statement of Charges for Government Property Lost, Damaged, or Destroyed, is used. This authorizes the Air Force to take the amount owed out of your pay. Remember, if you elect to use either of these methods of payment, you are acknowledging that the loss of, or damage to, the item was your fault. Furthermore, the Air Force retains title to any lost item, even though you had to pay for the item and it was later found.

Report of Survey. Whenever an individual will not admit pecuniary liability, or when the amount involved is $250 or more, a DD Form 200, Report of Survey, must be prepared. There are two officers directly involved in a Report of Survey: the appointing authority and the investigating officer. The appointing authority is a commander or other officer having jurisdiction over the individual who has custodial responsibility for the property in question. The appointing authority appoints a survey officer (the investigating officer), whose duty is to make a detailed and impartial investigation (survey) of the circumstances connected with the loss, damage, or destruction of the property described in the Report of Survey.

If the Report of Survey is approved, the person responsible for the custody of the property in question is relieved of the responsibility for paying for that property. But if the authorities decide from the evidence that the individual was negligent in caring for the property, the individual must reimburse the Air Force by either the Cash Collection Voucher or Statement of Charges.

Exercises (029):

1. What is the purpose of a Report of Survey?

2. What is a Statement of Charges?

3. Who appoints the investigating officer for a Report of Survey.

4. What are two ways of reimbursing the government for lost, damaged, or destroyed property?

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AFR 5-1. *Air Force Publications Management Program.*
AFR 5-4. *Publications, & Numbering Systems.*
AFR 6-1. Policies, Procedures and Standards Governing Air Force Printing, Duplicating, Copying and Microform.
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AFR 95-7. *Audiovisual Services.*
AFR 127-101. *Ground Accident Prevention Handbook.*
AFR 205-1. *Information Security Program.* (Supplements DOD 5200. 1-R).
AFP 50-47. *USAF Communications Security (Transmission Security).*

NOTE: None of the items listed in the bibliography above are available through ECI. If you cannot borrow them from local sources, such as your base library or local library, you may request one item at a time on a loan basis from the AU Library, Maxwell AFB AL 36112, ATTN: ECI Bibliographic Assistant. However, the AU Library generally lends only *books* and a limited number of *AFMs*. TOs, classified publications, and other types of publications are not available. Refer to current indexes for the latest revisions of and changes to the official publications listed in the bibliography.

BEST COPY AVAILABLE

GLOSSARY

Abberation—An optical defect in a lens which causes imperfect images.

Abrasion marks—Dark lines or scratches on negative or print emulsions which are usually caused by winding roll film too tightly, or rubbing the emulsion prior to development.

Absorption—Optically, absorption is the partial or total retention of light entering a lens.

Accelerator—An alkali which is added to a developing solution to increase the rate of development.

Acetate base—A noninflammable photographic film base, which is also known as a safety base.

Achromatic lens—A lens which is corrected for chromatic aberration.

Actinic light—Light capable of causing photochemical changes in a sensitive emulsion.

Additive process—A photographic color process which produces color by the superposition of the separate primary colored lights on the same screen.

Aerial perspective—The impression of depth in a photograph through progressively diminishing detail caused by haze.

Air bells—Small air bubbles which stick to the surface of an emulsion during processing and leave small spots unaffected by the solution. These bells are removed through agitation.

Alkali—A substance which can neutralize acids. Alkalis are used as accelerators in photographic developers.

Anastigmat—A lens which has been corrected for astigmatism and, therefore, focuses vertical and horizontal lines with equal brightness and definition. Anastigmatic lenses are also free from other common aberrations.

Angle of view—The angle formed when two lines are plotted from the center of a lens to the two distant corners of the negative.

Angstrom unit (A)—A unit of measure equal to one ten-thousandth of a micron, one-tenth of a millimicron, or one ten-millionth of a millimeter. Commonly used to express the length of light rays.

Anhydrous—Destitute of water, especially water of crystallization. Refers to chemical salts and means the same as desiccated.

Antihalation backing—An opaque backing on film to prevent reflection from the back surface of the film base.

Aperture—The lens opening that regulates the intensity of light reaching the film.

Apochromatic lens—A lens that focuses the rays of all colors on practically the same plane. Used for the most exacting color work.

Avoirdupois—System of weights and measures consisting of grains, ounces, pounds, fluid ounces, and quarts. Commonly used in the United States and Great Britain.

Bleach—To convert a silver image into silver halides prior to toning a print or intensifying a negative.

Blisters.—Small bubbles forming under an emulsion due to the detachment of the emulsion from its base. Blisters are caused by some fault in processing.

Brightness range—Variation of light intensities from maximum to minimum. Normally, it refers to the subject to be photographed. For example, a particular subject may have a range of one to four; that is, four times the amount of light is reflected from the brightest high light as from the least bright portion of the subject.

Brilliance—The degree of intensity of a color or colors.

Brilliant—The quality of a print or negative showing distinguishable tones from high lights to shadows.

Bromide paper—A photographic printing paper with an emulsion composed largely of silver bromides. Bromide papers are relatively fast and usually printed by projection.

Carbonates—Certain alkaline salts, such as potassium carbonate and sodium carbonate, which are used as an accelerator in a developer.

Catchlights—Reflections of a light source in the eyes of a portrait subject.

Characteristics curve—A curve plotted to show the relation of density to exposure. Sometimes called the H and D curve, it is formed by plotting the density values of film or paper.

Chiaroscuro—The arrangement of light and dark masses in a pictorial composition.

Chloride paper—A photographic printing paper with an emulsion made sensitive largely through silver chloride. Normally used for contact printing, it requires longer exposure than bromide or chloro-bromide paper.

Chloro-bromide paper—A photographic printing paper with an emulsion containing a mixture of silver chlorides and silver bromides. Used basically for enlarging.

Circle of confusion—The size of an image point formed by a lens. It is a decisive factor in establishing the maximum and minimum performance of a lens.

Clumping—The effective increase in grain size in an emulsion caused by the partial overlapping of grains of silver.

Color—A sensation produced in the eye by a particular wavelength or group of wavelengths of visible light.

Color sensitivity—The response of a photographic emulsion to light of various wavelengths.

Condenser—An optical system in projection printers used to collect divergent rays of the light source and to concentrate them on the enlarger lens.

Contact print—A photographic print made by placing a sensitized emulsion in direct contact with a negative and passing light through the negative.

Contrast—Subject contrast is the difference between the reflective abilities of various areas of a subject. Lighting contrast is the difference in intensities of light falling on various parts of a subject. Inherent emulsion contrast, which is determined by the manufacturer, is the possible difference between the maximum and minimum densities of the silver deposits with a minimum variation of exposure. Development contrast is the gamma to which an emulsion is developed. It is controlled by the developer, time, temperature, and agitation.

Convertible lens—A photographic lens consisting of two or more elements, which can be used individually or in combination to give several focal lengths.

Covering power—The capacity of a lens to give a sharply defined image to the edges of the sensitized material, it is designed to cover at the largest possible aperture.

Crop—To trim or cut away the unnecessary portions of a print to improve its composition.

Curtain aperture—The slit in a focal plane shutter which permits the light to reach the film. The size of the slit may be either fixed or variable.

Cyan—A blue-green (minus red) color.

Definition—The ability of an emulsion to record fine detail, or the ability of a lens to reproduce fine detail. Also called resolving power.

Deliquescent—The ability of a chemical salt to absorb moisture directly from the atmosphere.

Density—The degree of blackening of a silver deposit in an emulsion in relation to the light incident upon it.

Desensitizer—A chemical agent which decreases the color sensitivity of a photographic emulsion. Used to facilitate developing under a comparatively bright light.

Desiccated—A term applied to chemicals in which all moisture has been eliminated.

Developer—A solution which makes the latent image in an exposed emulsion visible.

Diaphragm—An adjustable aperture which controls the amount of light passing through a lens.

Dichroic fog—A two-color stain observed in films or plates. Appears green by reflected light and pink by transmitted light.

Dodging—A process for holding back light from certain areas of sensitized material to avoid overexposure in these areas.

Double exposure—The intentional or unintentional recording of two separate images on a single piece of sensitized material.

Double extension—A term used to describe a bellows which has an extended length of about twice the focal length of the lens being used.

Dry mounting—Cementing a print to a mount by placing a thin tissue of thermoplastic material between the print and the mount and applying enough heat to melt the tissue.

Efflorescence—The process by which a chemical salt loses its water of crystallization upon exposure to air.

Emulsion—A light-sensitive layer of silver salts suspended in gelatin, which is spread over a permanent support, such as film, glass, or paper.

Emulsion speed—The factor which determines the exposure necessary to produce a satisfactory image. It is commonly expressed in A. S. A. or Weston emulsion numbers.

Enlargement—A print made from a negative or a positive by projecting an enlarged image on sensitized material.

Exposure—The product of time and intensity of illumination acting upon photographic material.

F/number—A term denoting lens aperture.

Fading—The gradual elimination, usually of a print image, due to the action of light or other oxidation.

Filter—A piece of colored glass or gelatin used to modify or exaggerate contrast, to compensate for the difference in color sensitivity between the film and the eye, or to provide primary color separation in color photography.

Filter factor—The number by which the correct exposure without a filter must be multiplied to obtain the same effective exposure with a filter.

Flat—Denotes the lack of contrast in a print or negative.

Flatness of field—The quality of a lens which produces sharpness of image both at the edges and at the center of a negative.

Focal length—The distance between the center of a lens and the point at which the image of a distant object comes into critical focus.

Focal plane—The plane at which the image is brought into critical focus. It is the plane occupied by the film.

Focus—The point at which rays of light converge to form an image after passing through a lens.

Fog—A veil or haze over a negative or print, which is caused by undesired chemical action or light.

Foot candle—The intensity of light falling on a surface placed 1 foot away from a point light source of 1 candle power.

Frilling—The detachment of the emulsion from its support around the edges. Caused by excessively warm developer or excessive amounts of alkali.

Gamma—A numerical measure of the contrast to which an emulsion is developed.

Gamma infinity—The maximum contrast to which an emulsion can be developed.

Gradation—The range of densities in an emulsion from high lights to shadows.

Grain—Silver particles or groups of particles in an emulsion, which become noticeable and objectionable when enlarged.

Gray scale—A series of densities in definite steps ranging from white to black. Same as sensitometric strip.

Halation—A blurred effect, resembling a halo, usually occurring around bright objects. Caused by reflection of light rays from the back of the negative material.

Halftones—Middle tones lying between shadows and high lights.

Halides (or haloids)—Binary compounds containing any of the following elements: chlorine, bromine, iodine, fluorine.

Halogen—Iodine, fluorine, chlorine, and bromine are known as halogens.

Hard—Denotes excessive contrast.

High lights—The brightest parts of a subject, which are represented by the denser parts of a negative and the light gray and white tones of a print.

Hyperfocal distance—The distance from the lens to the nearest plane in sharp focus, when the lens is focused at infinity.

Imbibition—The act of absorbing. The process of dye transfer in the washoff relief process of making color prints.

Incandescent—Glowing with heat, such as the tungsten filament in an incandescent lamp.

Infinity—A distance so far removed from an observer that the rays of light reflected to a lens from a point at that distance may be regarded as parallel. A distance setting on a camera focusing scale, beyond which all objects are in focus.

Latent image—The invisible image formed in an emulsion by exposure to light. It is rendered visible by the process of development.

Latitude—Exposure latitude is the quality of a film, plate, or paper which allows variation in exposure without damaging the image quality. Development latitude is the allowable variation in the recommended developing time without noticeable differences in contrast or density.

Lumen—A measurement of light, equal to the amount of light falling on a foot-square surface which is 1 foot away from a point light source of 1 candlepower.

Magenta—A reddish-blue (minus green) color.

Mask—A negative image of a color transparency, of thin but varying density, used to key down color intensities of a color transparency.

Masking—A corrective measure used in three-color photography to compensate for the spectral absorptive deficiencies in pigments, dyes, and emulsions. This compensation improves the accuracy of color reproduction.

Matrix—A gelatin relief image used in the washoff relief process of color photography.

Monochromatic—A single color.

Nitrate base—A photographic film base composed of cellulose nitrate. Highly inflammable.

Objective—A term applied to a lens that is used to form a real image of an object.

Opacity—Resistance of a material to the transmission of light.

Opaque—A condition of an object which prevents the transmission of visible light.

Oxidation—The process of combining a substance with oxygen.

Perspective—The illusion of three dimensions created on a flat surface.

Preservative—A chemical, such as sodium sulfite, which, when added to a developing solution, tends to prolong its life.

Primary color—Any one of three components of white light—blue, green, and red.

Reflection—The diversion of light from any surface.

Resolving power—The ability of an emulsion to record fine detail, or of a lens to reproduce fine detail.

Restrainer—Any chemical, such as potassium bromide, which, when added to a developing solution, has the power of slowing down the developing action and making it more selective.

Reticulation—The formation of a wrinkled or leather-like surface on a processed emulsion due to excessive expansion or retraction of the gelatin caused by temperature changes or chemical action.

Reversal—A process by which a negative image is converted to a positive. A negative is developed, reexposed, bleached, and redeveloped to form a positive.

Scale—Scale is the ratio of a linear dimension in the subject to the corresponding dimension in the photograph.

Secondary colors—Colors formed by the combination of two primary colors. Yellow, magenta, and cyan are the secondary colors.

Sensitizer—Dyes used in the manufacture of photographic emulsions. Sensitizers can be of two types: one to increase the speed of an emulsion; the other to increase its color sensitivity.

Sensitometer—A device for producing on sensitized material a series of exposures increasing at a definite ratio. Such a series is needed in studying the characteristics of an emulsion.

Sensitometric strip—A series of densities in definite steps ranging from white to black.

Separation negatives—Three negatives, each of which records one of the three primary colors—blue, green, and red.

Time-gamma-temperature curve—A curve of developing time plotted against developed contrast or gamma. The contrast for any given time may be read directly from the curve, or vice versa. The curve applies only to one particular developer and emulsion.

Tone—In photography, this usually applies to the color of a photographic image or, incorrectly, to any distinguishable shade of gray.

Toning—A method for changing the color or tone of an image by chemical action.

Transmission—The ratio of light passed through an object to the light falling on it.

Soft—A term used to describe prints and negatives with low contrast.

Stock solution—Photographic solution in concentrated form and intended to be diluted for use.

Subtractive process—A process in color photography, using the colors magenta, cyan, and yellow. Contrasted with the additive color process.

Working solution—A photographic solution which is ready for use.

Answers for Exercises

CHAPTER 1

Reference:

001 – 1. a. Abilities.
b. Five; Air Force specialty code (AFSC).
c. Five; 1—helper, 3—semi-skilled, 5—skilled, 7—journeyman, 7—advanced, 9—superintendent.

002 – 1. b, c, d.

003 – 1. 1. b, 2. a, 3. e, 4. d, 5. c.

004 – 1. 3 level.
004 – 2. 5 level.
004 – 3. 7 level.

005 – 1. Training to qualify skilled airmen who are retraining into a different career field or career ladder; contract special training; ATC Special Resident Training.

005 – 2. General prerequisites for qualifying for formal training; retainability requirements after training has been received; reporting instructions; and general information on ATC courses. Volume 2 contains course announcements.

006 – 1. Field evaluation visit; direct correspondence questionnaire; and job performance evaluations. The ability of graduates to perform required duties; how well graduates remember what they are taught; whether the STS or school needs to be changed; and whether more evaluation is needed in specific career field areas.

CHAPTER 2

007 – 1. a. Classified.
b. Unclassified.
c. For Official Use Only.
d. Unclassified but of possible intelligence value.

008 – 1. a. Top Secret.
b. Secret.
c. Confidential.
d. Confidential.
e. For Official Use Only.

009 – 1. a. Messenger.
b. Encrypted radio message.
c. Registered mail.

010 – 1. a. Poor physical security.
b. Poor planning.
c. Awe of rank.
d. Talk around, paraphrasing, incomplete references, self-made reference system.

011 – 1. To prevent the disclosure of information containing intelligence indicators that can be used to degrade operational effectiveness.

011 – 2. As a photographer involved in documenting various happenings around the base, some of which may be sensitive, discussing these happenings in public could result in the release of possible intelligence indicators.

011 – 3. Operations, procedures, and communications.

CHAPTER 3

012 – 1. a, d, e.

013 – 1. a, c, d, f.

014 – 1. a, c.

015 – 1. Crack the valve; reclose valve; attach regulator; check the adjusting screw on the regulator and make certain that it is released before opening the cylinder valve.

016 – 1. b, d, e, f.

CHAPTER 4

017 – 1. When properly completed, the work request becomes the source for all pertinent information about a photographic assignment including the cost of materials and manpower required.
017 – 2. Laboratory administrative personnel.
017 – 3. Supervisors.

018 – 1. To provide information to lab administrative personnel on all work requests received by the photo lab that are being worked on or have been completed and filed.
018 – 2. Work request number; requester's organization or office symbol; date received; description of work; date completed.
018 – 3. To locate and determine the status of all work requests being accomplished or already completed.
018a – 1. To evaluate the manning requirements of your lab.
018a – 2. From work requests.
018a – 3. Outside exposures; inside exposures; copy camera exposures; black-and-white negatives delivered; color negatives delivered; contact prints; and production prints.

019 – 1. Locate AF Form 80; find the proper file category on the Form 80; look through the files until you find the file category you are looking for. Look through the file category folder to locate the correspondence. Items in the file are filed by date with the most recent item in the front of the folder.

020 – 1. a. Confidential.
b. 12–50.
c. don't.

021 – 1. a. True.
c. True.

022 – 1. a. 10B1–6–3–1.
b. 10B1–7–2–21.
c. Camera, copying still picture camera, P/N 01-1392, Model SFS-35 (sickles).
d. Ground camera, press, Type C-6 (Graflex).

023 – 1. a. Properly and uniformly.
b. Instructions.
c. 95.
d. Operating instruction.
e. Task.
f. Manufacturer.
g. Bulletin.

024 – 1. a, c, e.

025 – 1. a. Locally.
  b. Base (acetate).
  c. Alpha suffix.
  d. Negative numbers, calendar year, exposing unit, and security classification.

026 – 1. b. True.
  d. True.

027 – 1. Original negatives properly lettered IAW AFR 95-4; captions (AF Form 397 or 398); a high-quality 4x5-inch (10 x 12cm) print of each negative.

027 – 2. Contact.

028 – 1. e, g, h, j.

028 – 2. a. Mental.
  b. Federal.
  c. Regulations.
  d. Unpublished.
  e. Civil; criminal.

029 – 1. To determine the cause in the event that equipment is lost, damaged, or destroyed.

029 – 2. A Statement of Charges authorizes the Air Force to take money owed out of your pay.

029 – 3. The commander appoints an investigating officer who conducts the Report of Survey.

029 – 4. DD Form 1131, Cash Collection Voucher; DD Form 200, Report of Survey.

STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE
23132 01 22
GENERAL SUBJECTS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover your answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you have to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If mandatorily enrolled student, process questions or comments through your unit trainer or OJT supervisor. If voluntarily enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE. In parenthesis after each item number on the VRE is the Learning Objective Number where the answer to that item can be located. When answering the items on the VRE, refer to the Learning Objectives indicated by these Numbers. The VRE results will be sent to you on a postcard which will list the actual VRE items you missed. Go to the VRE booklet and locate the Learning Objective Numbers for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

MULTIPLE CHOICE

1. (001) What AFSC will you be awarded after you complete this CDC?

   a. 23112.
   b. 23132.
   c. 23152.
   d. 23192.

2. (001) Which one of the following statements regarding the Military Classification System is true?

   a. The specialty numbers are the same for each military branch.
   b. Each position is identified by a six-digit number.
   c. Positions are grouped according to common knowledge, skills, and abilities.
   d. Each duty is classified into a specialty career field known as a Military Specialty Code.

3. (002) Which one of the following is not mandatory for upgrade to the 3 level?

   a. High school chemistry course.
   b. Normal color vision.
   c. Experience in still photography.
   d. Completion of this CDC.

4. (003) When you successfully complete your 3-level training, you will

   a. start working toward your 5 level.
   b. be promoted to senior airman.
   c. begin training as a supervisor.
   d. complete your on-the-job training.

5. (003) The major difference between AFSC 23132 and 23152 is that the latter has

   a. more time in grade.
   b. fewer supervisory responsibilities.
   c. received more management training.
   d. been to an advanced photo school.

6. (004) As a 3-level photographer, you would be expected to do all of the following except

   a. perform pictorial research.
   b. plan and schedule work assignment.
   c. employ visual evaluation.
   d. mix finishing solutions.

7. (004) What Air Force regulation contains specialty descriptions?

   a. AFR 12-50.
   b. AFR 39-1.
   c. AFR 50-5.
   d. AFR 95-4.

8. (005) What type of special training is given when new weapons, or support systems are developed and an initial cadre of personnel need to be trained?

a. Field Training.
b. Familiarization Training.
c. ATC Special Resident Training.
d. Contract Special Training.

9. (005) What Air Force manual would state the eligibility requirements for attending the Still Photojournalistic Techniques Course at Lowry?

a. AFM 50-1.
b. AFM 50-5.
c. AFM 50-23.
d. AFM 50-38.

10. (006) The USAF formal school graduate evaluation program determines

a. whether the supervisors need more training.
b. how long it takes to train an airman.
c. when each graduate is eligible for promotion.
d. how well the graduate remembers what he was taught.

11. (007) The two broad categories of official information are

a. classified and unclassified.
b. Secret and Confidential.
c. Secret and For Official Use Only.
d. classified and For Official Use Only.

12. (008) Exceptionally grave damage to national security could result from the unauthorized disclosure of

a. Secret information.
b. Top Secret information.
c. Confidential information.
d. Information of Possible Intelligence Value.

13. (008) Serious damage to the national security could result from unauthorized disclosure of what level of classified information?

a. Secret.
b. Priority.
c. Confidential.
d. "Eyes Only."

14. (009) What are the four basic modes of communication?

a. Mail, messenger, telephone, and courier.
b. Radio, mail, courier, and telephone.
c. Messenger, mail, radio, and teletype.
d. Telephone, messenger, radio, and mail.

15. (009) The guarantee that a message will reach the right person is known as

a. speed.
b. security.
c. reliability.
d. protection.

16. (010) If you try to get information across by changing the words, you are guilty of

a. paraphrasing.
b. incomplete reference.
c. self-made disclosure.
d. talk-around.

17. (011) The prevention of disclosure of information containing intelligence indicators that can be used to degrade operational effectiveness is the purpose of which security program?

a. TRANSEC.
b. COMSEC.
c. TELSEC.
d. OPSEC.

18. (012) Which one of the following is an approved operating practice in a photographic facility?

a. Remove rings and watches before operating machines.
b. Use tinfoil as a short-term fuse.
c. Place a timer on a rubber mat in a processing sink.
d. Overload circuits when you need more power.

19. (012) Why should you remove your rings and watches before you operate a processing machine?

a. To keep from losing them in the solutions.
b. To reduce the possibility of being shocked.
c. To keep from scratching the film.
d. To allow you to reach into small spaces.

20. (013) Which one of the following is the least dangerous for identifying an unknown chemical?

a. Taste a drop of the chemistry from your fingertip.
b. Test the chemical by adding water without stirring..
c. Mix the chemical with a known ingredient and note the reaction.
d. Cautiously sniff the bottle held at a distance from your nose.

21. (013) Which one of the following is true regarding proper chemical safety?

a. Induce vomiting if a photodeveloper chemical is swallowed.
b. Wash chemicals from your eyes with as little water as possible.
c. Wear a respirator when you mix powdered chemicals.
d. Be sure that the chemical mixing room vents are closed tightly to prevent fumes from escaping.

22. (014) Which one of the following statements is true concerning compressed nitrogen gas?

a. Nitrogen is oderless, tasteless, and colorless.
b. Nitrogen cannot cause asphyxiation.
c. Close all windows and doors before you use compressed nitrogen.
d. Never chain nitrogen cylinders to the wall.

23. (014) What would be the most probable reaction if the top of a nitrogen cylinder were cracked during handling?

a. It would burst into flames.
b. The escaping gas would produce instant freezing.
c. You would start vomiting after inhaling the noxious fumes.
d. The cylinder could become a deadly projectile.

24. (015) What is the first step in connecting a new gas cylinder to your agitation system?

a. Release the handwheel.
b. Open the regulator.
c. Open the valve slightly.
d. Adjust the union.

25. (016) When you knowingly violate a safety rule, which principle of mechanical safety are you neglecting?

a. Alertness.
b. Planning.
c. Self-discipline.
d. Keeping physicallyt fit.

26. (017) Part II of AF Form 833 provides spaces for recording the

a. workload data.
b. requester's name and organization.
c. justification for the work to be done.
d. work request number.

27. (017) Part II of AF Form 833 should be completed properly because it

a. is the sole justification for the job to be done.
b. is the source for photo lab operating costs.
c. is the photographer's specific instructions.
d. gives the requesters name, organization, and phone number.

28. (018) The work request log can be used by laboratory administrative personnel to

a. record operating costs.
b. locate filed negatives.
c. determine the job to be done.
d. schedule work.

29. (018) Answering inquiries on the status of work requests is one of the responsibilities of the

a. photographers.
b. laboratory administrative personnel.
c. darkroom personnel.
d. requester.

30. (019) The AF Form 80, Files Maintenance and Disposition Plan, should be kept

Omit

a. in the very front of the first file drawer.
b. on the laboratory manager's desk.
c. on top of the filing cabinet.
d. on the work order control desk.

31. (019) General correspondence is filed by

a. date, with the most recent material at the front of the folder.
b. date, with the most recent material in the back of the folder.
c. subject, alphabetically.
d. date, alphabetically.

32. (020) The photo lab negative file may contain negatives with a security classification, not higher than

a. Secret.
b. Confidential.
c. Top Secret.
d. Crypto.

33. (020) Which of the following should be filed?

a. Copy negatives that satisfy the needs of one user.
b. Negatives of practice assignments.
c. Pictures used for a damage report.
d. Extra negatives not suitable for printing.

34. (020) Negatives used for a damage report should be kept on file for at least

a. 60 days.
b. 90 days.
c. 120 days.
d. 180 days.

35. (021) Which of the following technical orders contains information and instructions on safety and preventive maintenance?

a. Methods and Procedures Technical Order (MPTO).
b. Time Compliance Technical Order (TCTO).
c. Technical Order Index.
d. Numerical Index Technical Order.

36. (022) Which one of the following Technical Order Indexes would be used to locate a technical order that has been assigned a new number?

a. TO 0-1-01, Numerical Index and Requirement Table.
b. TO 0-2-1, Alphabetical Index.
c. TO 0-4-1, Cross Reference Tables Index.
d. TO 0-1-10, Photographic Equipment, Supplies, and Sensitized Materials.

37. (022) Which of the following numbers identifies the technical order category covering photographic equipment?

a. 5.
b. 10.
c. 30.
d. 50.

38. (023) Which one of the following series of Air Force Regulations deals with audiovisual systems?

a. 5.
b. 30.
c. 95.
d. 100.

39. (023) Which one of the following statements is true regarding operating instructions?

a. Operating instructions are rigid in format.
b. Operating instructions do not have to be numbered.
c. Operting instructions provide general information about a task.
d. Operating instructions indicate who is responsible for performance of the task.

40. (023) Which one of the following statements is true regarding commercial publications?

a. Commercial publications are not used by photographic laboratories.
b. Commercial publications give only general information about items of equipment and photographic products.
c. Commercial publications should be discarded after they are read.
d. Commercial publications are normally furnished by manufacturer's to purchasers of their products.

41. (024) The distinction between record and nonrecord photography is

a. often subjective.
b. defined in AFR 95-7.
c. always determined by the lab chief.
d. unnecessary at the local level.

42. (024) Guidelines for determining what qualifies as record photography are covered in

a. AFR 95-1.
b. AFR 95-3.
c. AFR 95-6.
d. AFR 95-7.

43. (025) Which of the following Air Force regulations is the guideline for lettering and captioning still photography?

a. AFR 39-1.
b. AFR 50-5.
c. AFR 95-4.
d. AFR 127-101.

44. (025) Which of the following is not included as part of the negative lettering information?

a. Negative number.
b. Calendar year.
c. Security classification.
d. Photographer's name.

45. (026) Which of the following statements is true regarding captioning and identifying prints?

a. AF Form 398 must be used to identify all photographs.
b. The caption must include the photographer's name.
c. The best method for identifying prints is ink stamping.
d. Prints should be identified by overprinting on the front side.

46. (026) Each negative that is considered to be record photography must be

a. stamped.
b. published.
c. printed.
d. captioned.

47. (027) What three things must be included when forwarding a record photography package to the USAF Central Still Photographic Laboratory?

a. Original negative, caption, and cover story.
b. Caption, contact print, and model release.
c. Original negative, caption, and high quality print.
d. Model release, high quality printing, and duplicate negative.

48. (027) The Air Force regulation that contains detailed and special instructions on the submission of record photography to the USAF Central Still Photographic Laboratory is

a. AFR 95-1.
b. AFR 95-4.
c. AFR 95-7.
d. AFR 95-10.

49. (028) The symbol "©" on a printed document, indicates that the document is

a. classified.
b. controlled.
c. chartered.
d. copyrighted.

50. (028) Which of the following subjects can you legally copy to the same size and in color?

a. Coins.
b. Immigration papers.
c. Driver's licenses.
d. Paper money.

MAIL TO: ECI, GUNTER AFS AL 36118-5643

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012. PRINCIPAL PURPOSE: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package, and used by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's inquiry. Failure to provide all information would result in slower action or inability to provide assistance to the student.

I. CORRECTED OR LATEST ENROLLMENT DATA

1. THIS REQUEST CONCERNS COURSE (1-6)	2. TODAY'S DATE	3. ENROLLMENT DATE	4. AUTOVON NUMBER

5. SOCIAL SECURITY NUMBER (7-15) – –	6. GRADE/RANK	7. NAME (First initial, second initial, last name) (17) – (18) – (19-32)

8. ADDRESS (33-53)

OJT ENROLLEES: Address of unit training office with zip code. (54-75)

ALL OTHERS: Current mailing address with zip code.

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE	10. TEST CONTROL OFFICE ZIP CODE/SHRED (33-39)

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X	Place an 'X' through number in box to left of service requested
1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction. *(Provide Old or Incorrect data here)*
4	Request Grade/Rank change/correction.
5	Correct SSAN. *(List incorrect SSAN here.)* *(Correct SSAN should be shown in Section I.)*
6	Extend course completion date. *(Justify in "Remarks")*
7	Request enrollment cancellation. *(Justify in "Remarks")*
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 10 Originals were: [ ] Not received [ ] Lost [ ] Misused
9	Send course materials. *(Specify in "Remarks")* [ ] Not received [ ] Lost [ ] Damaged
10	Course exam not yet received. Final VRE submitted for grading on ______ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 10 not yet received. Answer sheet(s) submitted ________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on ______ (date).
13	Previous inquiry ([ ] ECI Fm 17, [ ] ltr, [ ] msg) sent to ECI on ______ (date).
14	Give instructional assistance as requested on reverse.
15	Other *(Explain fully in "Remarks")*

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16		
G	33	
K	VOL 33-35	GR 36-38
M	33-34	35-40
N	33-35	
P	VOL 33-35	
	TC 36-37	38
	DOE 39-45	
Q	33-34 00	38 1
	MC 39-42	

REMARKS *(Continue on reverse)*

OJT STUDENTS must have their OJT Administrator certify this record.

ALL OTHER STUDENTS may certify their own requests.

I certify that the information on this form is accurate and that this request cannot be answered at this station

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REFERENCE

(Textual reference for the answer I chose can be found as shown below.)

IN VOLUME NO ____________

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23132 02 7905

CDC 23132

APPRENTICE STILL PHOTOGRAPHIC SPECIALIST

(AFSC 23132)

Volume 2

Still Photographic Fundamentals

Extension Course Institute

Air Training Command

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THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

Preface

THIS SECOND of four volumes is designed to help you qualify as an *Apprentice Still Photographic Specialist*. Volume 2 contains information on light sources, exposure, black-and-white film, optics, and filters.

Chapter 1 is devoted to lighting. We delve into what might be considered the keystone of photography—light. Just as the talent of an artist is reflected by the use of delicate hues and shading, the professionalism that a photographer exhibits is marked by the manner in which light is used. With intelligent use of various lights and light sources, one's photographs can be made to reflect the desired mood, style, and impact. In Chapter 2 we cover the theory of photographic exposure and the various devices, and the procedures that are used to measure and calculate the brightness of a scene to determine proper exposure. Chapter 3 discusses various black-and-white films that are available to you. We discuss the criteria for selecting film and how the characteristics of the film affect your selection. Chapter 4 is devoted to photographic optics. In this chapter we cover such items as principles of photographic lenses, lens types and their effects, and the use of lenses for image control. Chapter 5 provides information on photographic filters. Many photographers think filters are used only to emphasize clouds in black-and-white pictures. But filters have many more uses, in both black-and-white and color photography. This chapter covers the theory of filter use as it applies to black-and-white work.

If you have questions on the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to the 3430th Technical Training Group/TTMZS, Lowry AFB CO 80230. Questions requiring immediate resolution may be directed to the course author, AUTOVON 926-4142, between 0730 and 1600 hours (MST), Monday through Friday. NOTE: Do not use the suggestion program to submit corrections for typographical or other errors.

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to Career Development, Behavioral Objective Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If this agent can't answer your questions, send them to ECI, Gunter AFS AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 15 hours (5 points).

Material in this volume is technically accurate, adequate, and current as of March 1978.

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NOTE: In this volume, the subject matter is developed by a series of Learning Objectives. Each of these carries a 3-digit alphanumeric identifier and is in boldface type. Each sets a learning goal for you. The text that follows the objective gives you the information you need to reach that goal. The exercises following the information give you a check on your achievement. When you complete them, see if your answers match those in the back of this volume. If your response to an exercise is incorrect, review the objective and its text.

Existing and Supplemental Light Sources

THE WORD photography comes from two Greek words that mean "making pictures with light." Light is a form of energy that causes chemical and physical changes. Most living things need the energy from sunlight to exist, and so does photography. In this section we cover some of the aspects of the behavior of light. Since you must use light to make a photograph, you must understand some of its principles.

1-1. Theory of Light

Just as an artist uses paint to make a picture, you use light to make a photograph. The artist puts the paint on the canvas; you will put light on a piece of film. Light makes photography possible and you must know how it behaves so that you can control it.

200. Discuss the properties of the theory of light.

Obviously you can not see without light. Just as obviously you cannot take a photograph without light. If light is so important to photography, then just what is light?

For our purposes, we define light as those radiations that can be seen. Light behaves differently under different conditions. If you can predict how light will behave in a given situation, then you can control light and make a good photograph.

Reflection. When light hits an object and is cast back, it is reflected; this light that falls on an object is called incident light. There are two types of reflection. Light that strikes a smooth, polished surface and reflects back at the same angle is known as specular reflection. Light that strikes a rough surface and reflects back in many directions is called diffused reflection. Figure 1-1 shows light reflected from both smooth and rough surfaces. Remember, reflections from rough surfaces are called diffused reflections and those from smooth or polished surfaces are called specular reflections. Diffused reflections form the middle tones in a photograph and specular reflections form the bright areas in a photograph.

Transmission. When light passes through a medium, such as a window or a lens, it is said to be transmitted. A medium that transmits nearly all of the light falling on it is transparent. A transparent object transmits nearly all of the light, and you can see objects behind it. Translucent media, such as frosted glass, transmit most of the light, but an object behind it can not be clearly seen. Figure 1-2 shows transparent and translucent objects.

Absorption. Light that is neither transmitted nor reflected is absorbed. An object that absorbs most of the light falling on it is opaque. Most objects are opaque. Both opaque and translucent objects have color. This is because they reflect the parts of light that make them appear a certain color.

Black objects appear black because they absorb nearly all of the parts of light. White things are white because they reflect the portions of light that make them appear white. Understand that no object completely absorbs or reflects all light. There is a certain amount of absorption or reflection in every object. If this were not true, we could not see them. For example, the windows in an air-conditioned car are usually tinted glass. They let most of the light pass through and are considered to be transparent. The tint however, absorbs some of the light to make the interior of the car cooler. Also, since the surface of the windows is highly polished, some of the light is reflected. So you see, it is the absorption and reflection properties of light that give objects color and allows us to see and photograph objects.

Refraction. Refraction is the bending of light rays as they pass through an object. Refraction occurs when

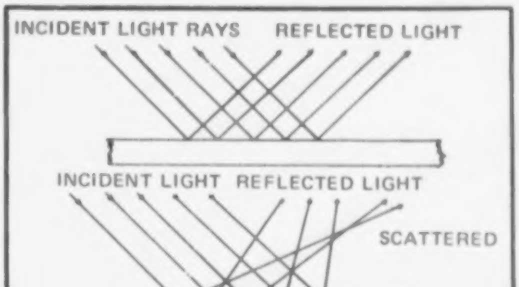

Figure 1-1. Specular and diffused reflections.

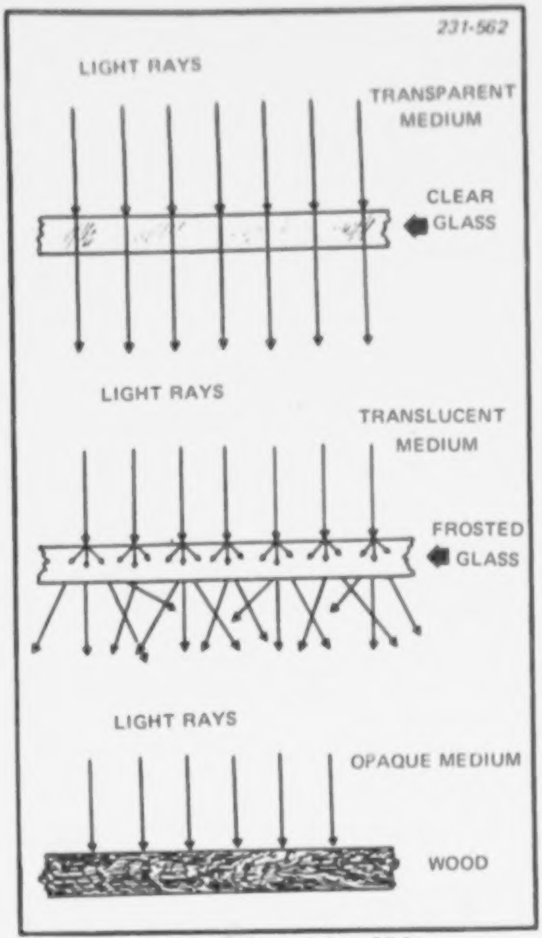

Figure 1-2. Transmission of light.

light passes through such things as water, glass, and photographic lenses. You probably have witnessed refraction of light in water. A canoe paddle partially immersed in water appears to be bent at the union between the water and the air. The lens on a camera, or any lens for that matter, bends light rays in a controlled manner. This allows you to recreate a scene in front of the camera on a piece of film behind the lens.

Dispersion. Dispersion is the separation of light into its individual colors. A prism can be used to separate white light in this manner (fig. 1-3). In nature, the water droplets that make up a rainbow cause dispersion of light. A camera lens would also disperse light if it were not corrected to prevent dispersion. Dispersion is undesirable for most photographic purposes. Through the years, however, lens manufacturers have practically eliminated the occurrence of dispersion; therefore you do not need to be too concerned with dispersion.

Exercises (200):

1. What are radiations that can be seen called?

2. What occurs when light hits an object and is cast back?

3. If you can clearly see an object through a medium, the medium is ________.

4. What happens to light that is neither transmitted nor reflected?

5. The reason objects look displaced in water is because the light rays are ______.

6. What are the light properties that allow us to see objects and to photograph them?

1-2. Daylight

There are two primary categories of light that you can use in photography. They are natural light (daylight and moonlight) and artificial light (flash, incandescent, etc.). Daylight is probably the most important light source, simply because you will use it most often. Once you understand how to use daylight, you should have no problem using other light sources.

In this section, we discuss the quality of daylight and how it can be affected by many factors. You will also learn that the direction of light in relation to your subject has a profound effect on the appearance of your photographs.

201. State the characteristics of daylight lighting, in terms of components and variations.

Daylight is composed of direct sunlight diffused through the earth's atmosphere, light reflected from the sky, and light reflected from objects on the earth's surface. The nature of daylight at any given time depends upon geographic location, time of day, season of the year, and prevailing weather conditions. Weather accounts for the greatest variation in daylight. When there is a minimum of atmospheric haze, the amount of direct sunlight is about 80 percent of the total light. A partially cloudy sky can reduce the intensity of direct sunlight by about one-third. A completely overcast sky reduces the sky light by 50 percent and direct sunlight by about 25 percent of their intensity on a clear day.

The natural lighting conditions determine when it is best to photograph an object outdoors. The position of the sun determines what shadows are cast and the position of the highlights (bright areas) of a scene. Of

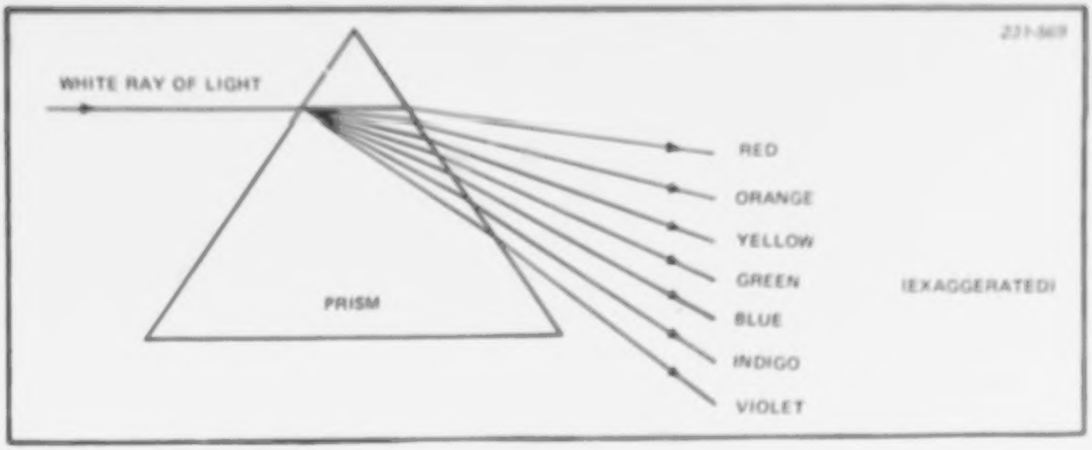

Figure 1-3. Dispersion of light.

course, it is impossible to change the position of the sun, but you may be able to change the position of your subject. What if you are going to photograph a subject or scene on a bright sunny day where the shadows are too deep and the highlights are too bright? If you can't move your subject you still have an alternative. Wait until you have an overcast day. On such days you won't have to worrry about too much contrast. Figure 1-4 gives a comparison of the same scene photographed on a sunny day and on an overcast day.

Since the sun travels in an arc, moveable subjects can be properly positioned to provide the lighting that you desire. In the early morning or late afternoon, long shadows are cast, but when it is close to noon, the shadows are much shorter.

Perhaps you have heard that the best way to take a photograph is with the sun coming over your back. This "rule" stemmed from early days of photography when photographic films were not sensitive enough to be used in shadows. It is no longer a rule but rather just another method of using daylight.

Frontlighting. This is *flatlighting*, which can be a problem because there are no visible shadows to create depth in a photograph. Another problem of facing your subject into the sun is that of eye squinting. Since the eyes are the most expressive part of a person's face, this is undesirable. See figure 1-5.

A better method of lighting your subject under sunny conditions is to have the sun strike your subject at an angle or to the side. The shadows cast, as shown in figure 1-6, make the photograph much more interesting.

Backlighting. What about facing your camera into the sun? This method is known as *backlighting*, and if done properly it makes for a successful photograph. You must be careful in aiming your camera and you should use a lens shade. The biggest problem with this type of lighting is that the subject's face is in a shadow. Special exposure considerations, the use of a reflector, or fill-in flash may be needed. A variation of backlighting is a situation known as *open shade*. Open shade means you place your subject in a shaded area, such as under a tree, using the open sky as your background. Since the entire subject is in the shaded area, the lighting is diffused and fairly even. Also, the open sky behind the subject makes a pleasing background. Here again, exposure is the major problem when using open shade, but the results are often very good. Figure 1-7 shows an open shade situation.

Exercises (201):

1. Name three components of daylight.

2. What causes variatons in the quality of daylight?

3. What are flatlighting, backlighting, and open shade?

1-3. Incandescent Light Sources

Besides daylight, you can use almost any form of light that gives your film adequate exposure, as long as the film you are using is sensitive to that color of light. The most common source of light other than daylight is the radiant emissions caused by the burning of materials. The light from these sources is called artificial light. Actually, the light itself is real, just as any other illumination. The reason it is called artificial is because of the source that makes the light. The torch, the candle, the oil lamp, gas mantle lamps, incandescent electric light bulbs, and photographic flash bulbs trace man's progress in producing controllable artificial light sources. These light sources all share the fact that they are incandescent and they all

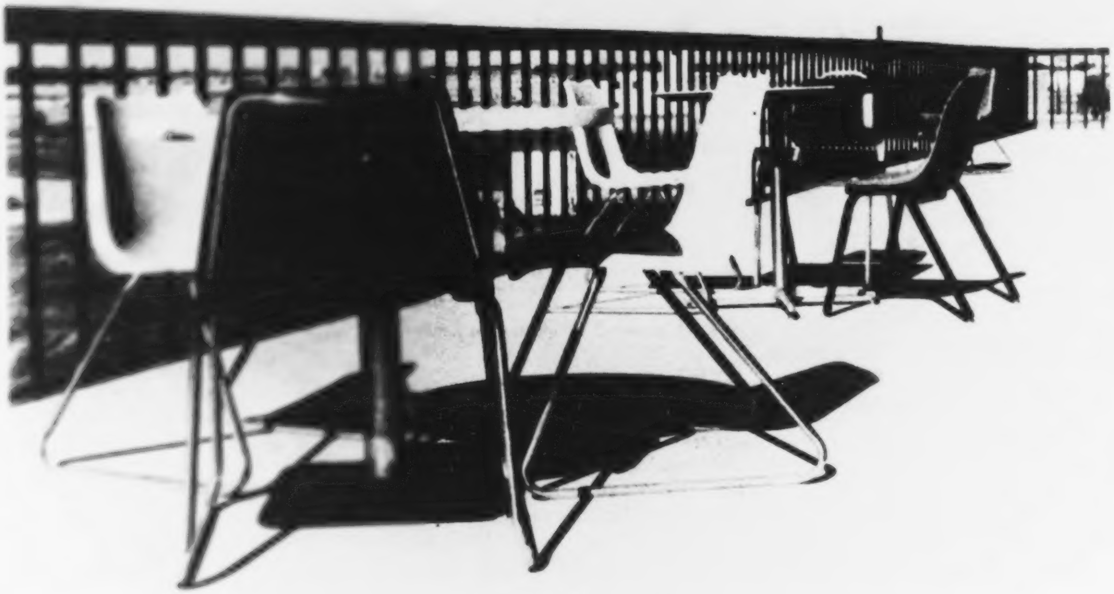

Figure 1-4A. Sunny scene.

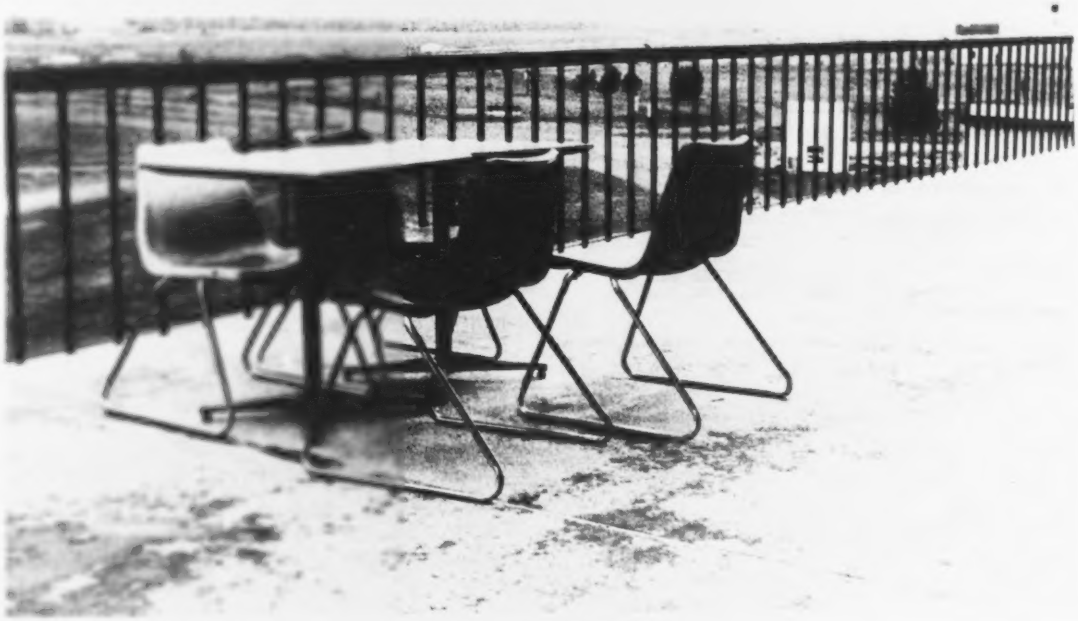

Figure 1-4B. Overcast scene.

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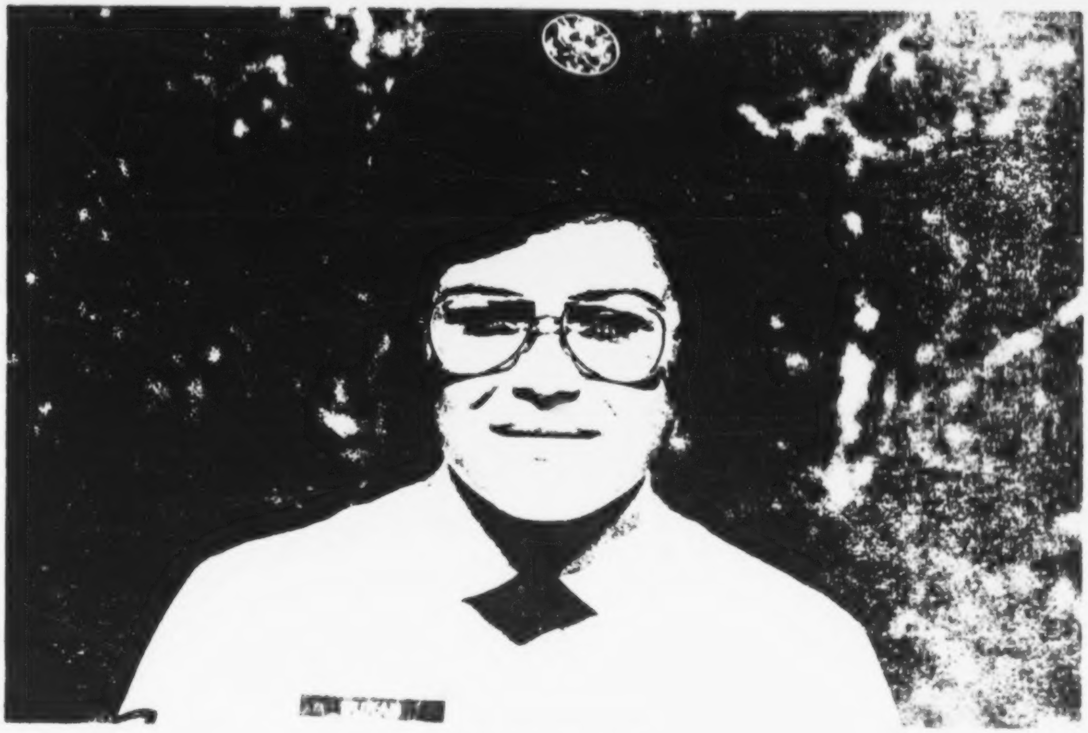


Figure 1-5. Front lighting.

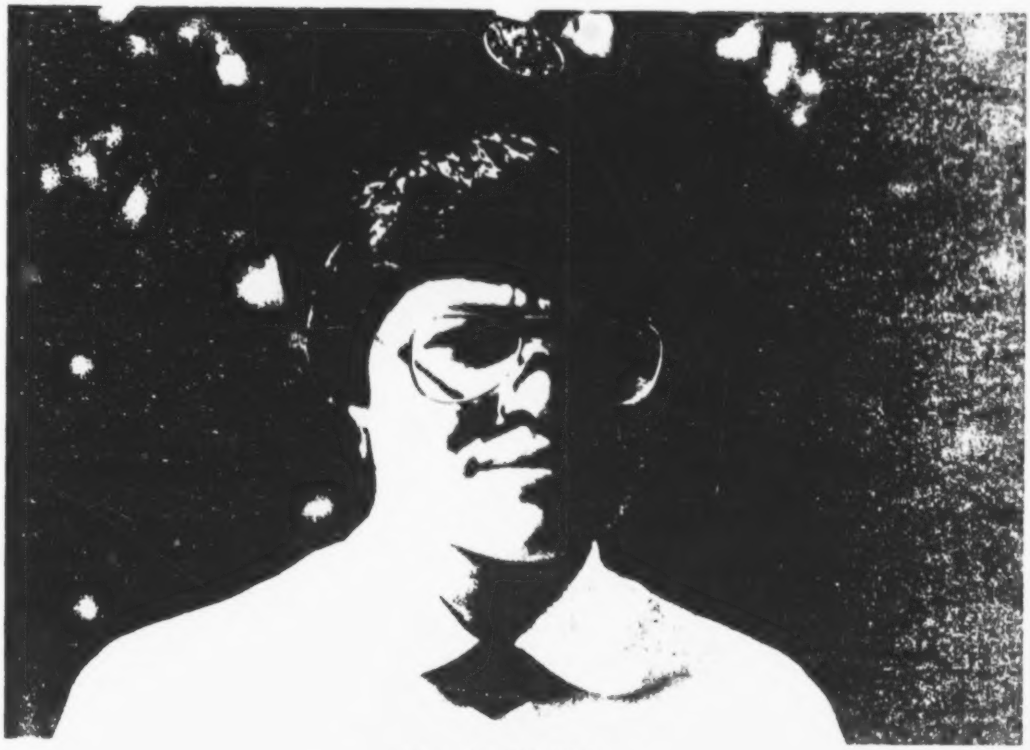


Figure 1-6. Side lighting.

Figure 1-7. Open shade lighting.

produce a certain amount of heat along with the visible light.

202. State why and how high-efficiency photographic lamps are used.

High-Efficiency Photographic Lamps. These lamps produce a continuous source of light for photography. Just as in the common household light bulb, light is produced by passing electrical current through a wire filament inclosed in an inert gas. These lamps also operate on standard household current and are equipped with a screwbase. By now, you may be wondering that since they are so similar to ordinary light bulbs, why do you need to use them? The difference is the light output and color quality. The filament in a photographic lamp can withstand higher heat; therefore, it produces more light.

The two basic types of these lamps are photoflood lamps and studioflood lamps. The difference between the two types is the color of the light that they produce. The greatest advantage of these lamps is their high efficiency. They are generally used in reflectors which makes them more efficient and the direction of the light can then be controlled. Also, since they have a screwbase, they can be put into regular household fixtures to raise the light level of any room and still retain a natural lighting effect. One of the disadvantages of these lamps is their short life.

When using these lamps, there are a few precautions that you must take. First of all, don't overload the electrical wiring like the person shown in figure 1-8. You must limit the total number of lamps that you are using based upon the capability of the electrical wiring in the building where you are photographing. Each 500-watt lamp draws about 5 amps of current on a 110 volt circuit. You can see that if you are on a 15 amp, 110 volt circuit with three lamps you are drawing the maximum amperage.

The exact wattage that can be used on any circuit can be determined through the use of the formula P = EI where P represents power in watts, E represents volts, and I represents amps. By simply multiplying the voltage of a circuit times the amperage it is rated at, you can determine the maximum wattage it will deliver safely. Suppose that you wanted to use a 110 volt circuit that is fused for or has a circuit breaker rated at 20 amps. Use the formula:

$$P = EI$$
$$P = 110 \times 20$$
$$P = 2200 \text{ watts}$$

Now you know that you can use any number or combination of lamps on this circuit as long as their combined wattage does not exceed 2200 watts.

You should cultivate a healthy respect for electricity. Recognize that it is a tool you can use to do your job but don't take chances with it. Never use a higher rated fuse in a circuit so that you can use more lamps. This is a dangerous practice because the electrical wiring can overheat and cause a fire. The other precautions that you must take are to keep combustible materials well away from the lamps and never splash water on the bulbs because they will shatter.

When using incandescent lamps your lighting arrangements are virtually limitless and you can see their effect before making an exposure. Generally, when using artificial light sources, try to duplicate the effect of natural lighting. Remember this when arranging your lights.

You may use a single lamp at the camera position. Or, if you desire, move a single lamp to the side of the camera so that it casts shadows in the same manner as sunlight. To lighten the shadows, place a second lamp to the other side of the camera. The second lamp can be a lamp of lower light output, or you can move a lamp of the same intensity farther away from the subject than the first lamp. The second lamp acts as a fill-in light to reduce the darkness of the shadows. You may use additional lamps to illuminate a background. Also, you can point a lamp at the back of the subject to provide a halo around the hair on a person's head. In any case, you still calculate the exposure from the main, or key, lamp. In most lighting situations, use the key lamp and the fill-in lamp to provide primary illumination, and spot lamps for the background and halo light.

Exercises (202):

1. Why are household bulbs not preferable for photographic purposes as opposed to high-efficiency photographic lamps?

2. Are any precautionary steps necessary when using high-efficiency photographic lamps? Explain briefly.

3. When you use incandescent light sources you should try to duplicate the effects of __________ lighting.

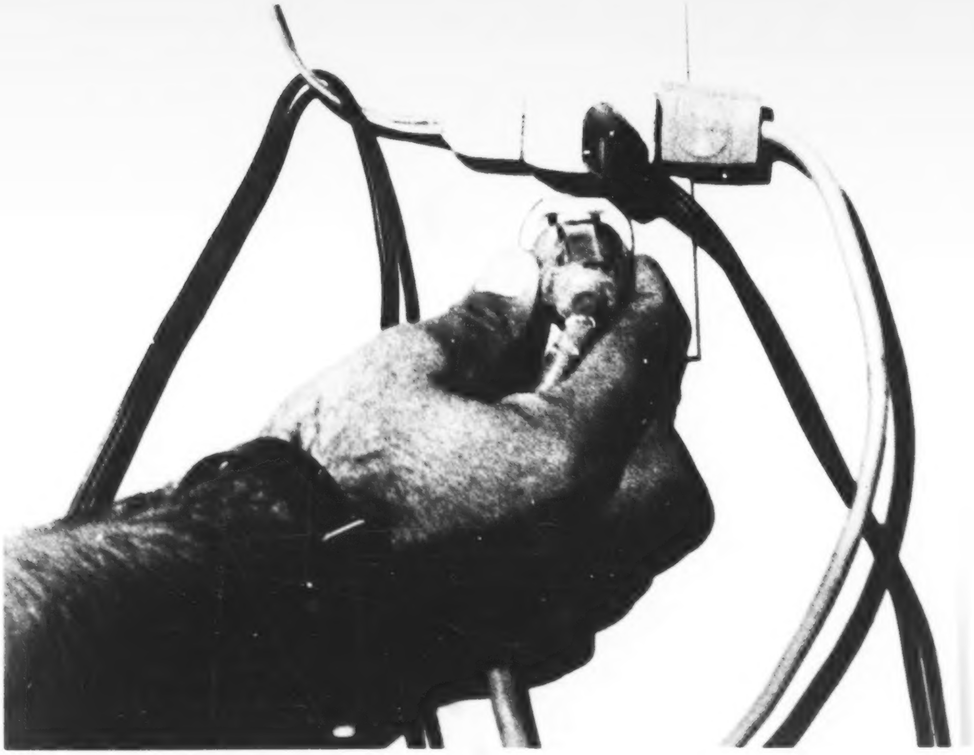


Figure 1-8. Electrical circuit overloading.

4. When using more than one lamp, how do you calculate the exposure?

203. State and explain briefly characteristics and advantages of electronic flash.

Electronic flash (fig. 1-9), is a repeating or intermittent source of photographic light. A flash tube that may be fired thousands of times is used in place of conventional flash bulbs. The flash tube is fired with power provided by batteries which are located within the unit or carried in a pack. Flash units designed for camera use are light, convenient, and quite powerful.

Aside from the convenience and portability of electronic flash, it has many advantages that make it the ideal light source for all around professional use. Its extremely short flash duration is not only useful for photographing action, but for minimizing the effect of camera and subject movement. The flash is a very penetrating light with the ability to light the dark areas without overlighting the bright areas.

It is especially suitable for portraits because it eliminates the need for hot, glaring lights that cause squinting, wrinkles, and self-consciousness. Its extremely brief flash has no effect on the subject's eyes. This eliminates contraction of the iris and results in the larger pupils which add character to your portraits. The color of the flash is high in blue content which makes it suitable for daylight color films and all black-and-white materials.

Many electronic flash units have automtic exposure control. You merely choose a setting (determined by the type of film you are using) and automatically the flash unit produces the proper amount of light for a perfect exposure. The farther away the subject is, the more light it provides; the closer the subject is, the less light it provides.

We mentioned that electronic flash units provide a very short exposure time. Their short flash duration freezes normal action and eliminates blurred pictures caused by camera movement. Thus, you may capture extremely rapid motion. Stopping motion is very effective when photographing such things as rotating machinery, rapidly moving bird wings, and other subjects in continuous motion. Also, you can stop the motion of a hammer hitting a light bulb or the end of a golf club coming into contact with a golf ball. Such subjects photographed with an electronic flash clearly show the individual pieces of the lightbulb as they are smashed or the compression of a golf ball at the moment of contact. Stopping action with an electronic flash is shown in figure 1-10.

Electronic flash is often used as the sole light source for indoor scenes. However, it is just as useful outdoors, even when the sun is shining. It can be used to fill in shadows and also to ~~stimulate~~ sunlight under

Simulate

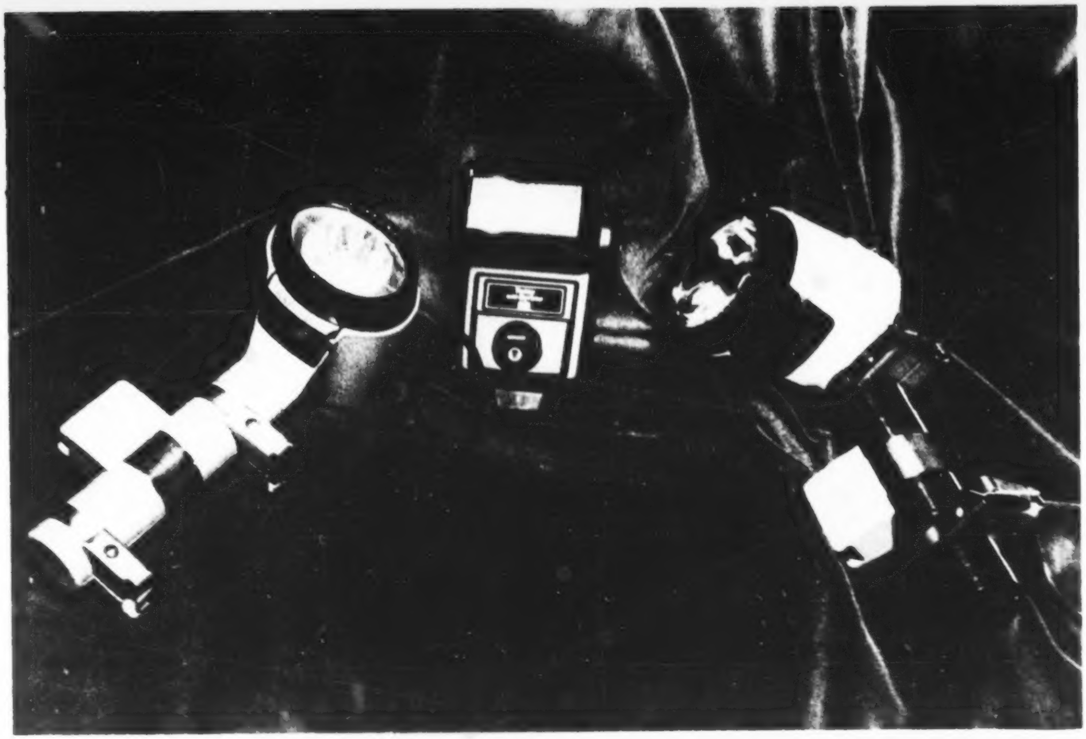


Figure 1-9. Electronic flash units.

hazy skies. When used to make bright highlights and cast shadows, electronic flash approximates natural sunlight conditions. Also, you may use a multiple flash setup to provide specialized illumination of a scene.

Exercises (203):

1. Name two distinct advantages of electronic flash.

2. Why is a short flash duration useful?

3. Is electronic flash effective as an outdoor light source? Explain briefly.

204. Identify characteristics and advantages of quartz ~~iodine~~ halogen lights.

All tungsten filaments are more efficient when working at high temperature. However, high temperatures cause rapid evaporation of the filament; therefore, in a conventionally constructed light bulb, the lamp life is short. Research has shown that if a halogen such as iodine vapor is used in the lamp, it combines with the evaporated tungsten, which is then attracted to the hottest local surface, the filament. The iodine thereby creates a regeneration cycle that increases filament life and eliminates bulb blackening.

Quartz iodine (also called tungsten-halogen) lamps are compact, ~~high~~ highly efficient for their size, and maintain constant color quality. They are available in a variety of sizes and color temperatures. They are commonly used in copy, studio, and motion picture work where they prove superior to other types of incandescent lighting.

Using quartz ~~iodine~~ halogen lights is similar to using photofloods or other types of continuous supplemental lighting. Exposure can be determined by using an exposure meter or by referring to manufacturer's exposure guides.

One point to remember when working with quartz ~~iodine~~ halogen lamps or any lighting system is safety. You must be sure that there is no overloading of circuits and that the lamps are handled correctly. One of the key safety hazards with quartz ~~iodine~~ halogen lamps is their intense heat. They should be handled with special heat resistant gloves when in use. Wearing gloves prevents fingerprints from being left on the quartz tube. These prints can etch into the glass because of the lamp's intense heat, and cause the lamp to shatter.

Exercise (204):

1. Which of the following lamp characteristics apply to the quartz ~~iodine~~ halogen lamp?
   a. Cool burning.
   b. Synchronized to camera.

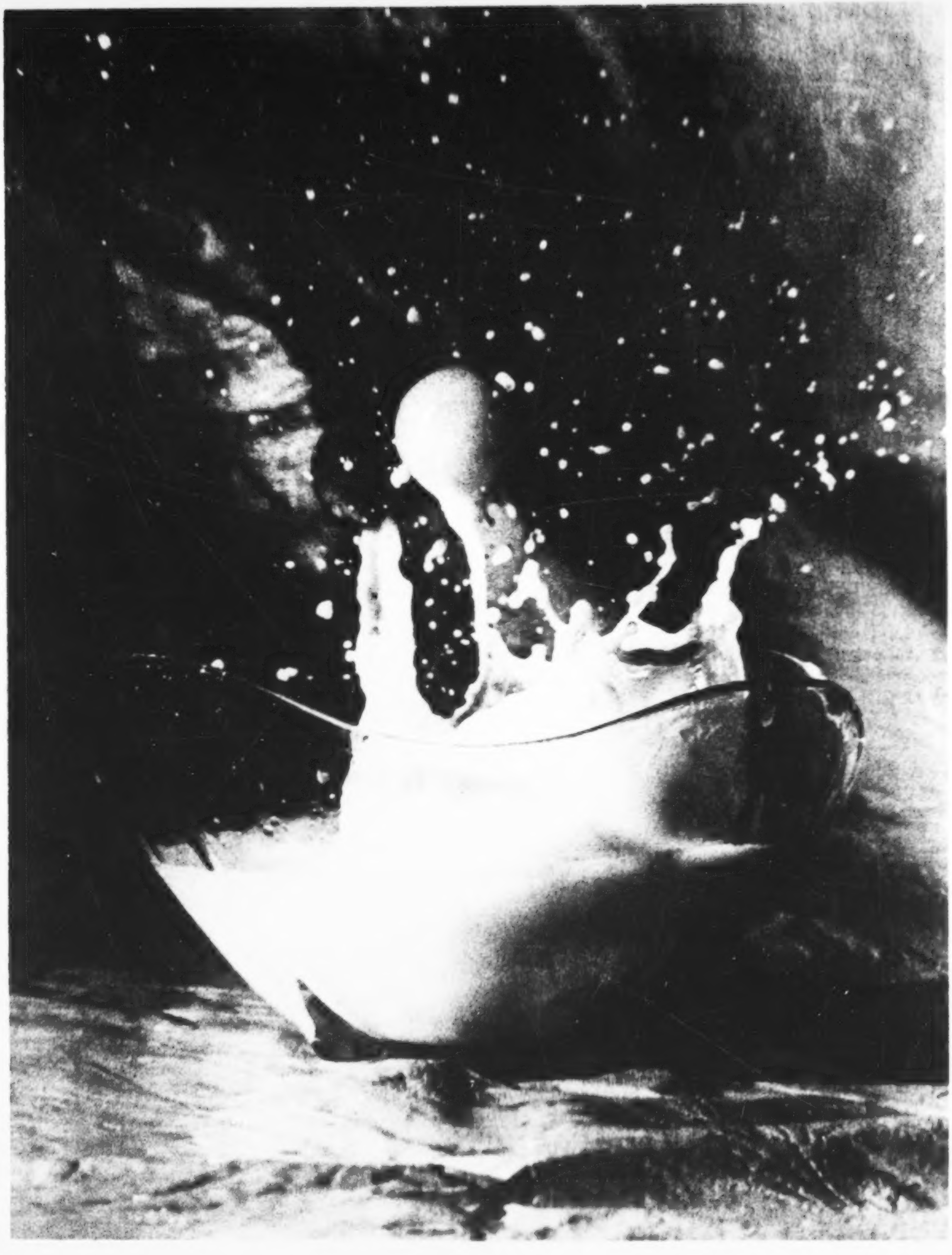


Figure 1-10. Stop action with electronic flash

c. High intensity.
d. Long life.
e. Should be handled with gloves.
f. Constant color temperature.
g. Intermittent light source.
h. Suitable for copy work.

205. Complete and explain a list of statements concerning the structure and function of fluorescent lighting.

The fluorescent light source uses the mercury-lamp principle. Essentially, the fluorescent lamp is a mercury-vapor lamp with vapor pressure and voltage adjusted so that the discharge produces little visible light, but creates a high emission of energy in the ultraviolet region. The inside of the glass tube is coated with a phosphor which absorbs the radiation emitted by the mercury vapor and converts the short ultraviolet invisible wavelengths into longer visible wavelengths, producing visible light.

The color of the light from a fluorescent lamp is controlled by the phosophor coating. Variations of this coating are manufactured to produce variations in illumination. These lamps may be given names as white fluorescent lights, daylight fluorescent lights, etc. You will be most concerned with fluorescent lighting when you go to offices to take pictures. If you want or need to use available light instead of your electronic flash or photofloods you will have no problems if you remember a few important points.

First, fluorescent lights pulse because of the alternating current. This means that 60 times a second the current changes directions. During each pulse the light quality and intensity change. Therefore, your camera exposure must catch the light when it is "on", rather than during one of these pulses. A shutter speed longer than 1/60 second will insure you catch the light properly.

The second point is that fluorescent lights are usually high in green light. This is no major problem in black-and-white work but is of great concern when you are using color film.

We do not want to scare you away from using fluorescent lights. They are really no problem. Since nearly all buildings use them, you should learn how to use fluorescent lights, not how to avoid them.

Exercises (205):

1. Complete the following statements about fluorescent lighting and explain briefly.
   a. The inside of a fluorescent tube is coated with __________. Why?

   b. Use a shutter speed of ________ when you use fluorescent lights. Why?

   c. Fluorescent lights are high in __________ light. When is this a factor?

79

Photographic Exposure

IN CHAPTER 1 we discussed the theory of light and the light sources that you will use in your work. In this chapter you will learn that in order to make a photograph, you must be able to control light. A properly exposed negative is the starting point towards producing a good photograph. You cannot produce an acceptable negative without controlling light. In this chapter we discuss the theory of photographic exposure and how photographic exposure is computed.

2-1. Exposure Factors

Photographic exposure is the controlled application of light on film. Exposure sets the photographic process in motion to produce an end product. You must properly expose the film if you want to produce an image with proper density and adequate detail.

206. State the basic formula for photographic exposure and the factors that control exposure.

The term "exposure" relates to the amount of image-forming light that is allowed to act upon the film. The two factors that determine exposure are the intensity of the exposing light and the amount of time the light is allowed to strike the film. Therefore, exposure is light intensity multiplied by time. Exposure can be expressed in the formula: $E = I \times T$, where intensity (I) multiplied by time (T) produces exposure (E).

You probably have experienced rainshowers of varying intensities. During a thundershower, a lot of water falls in a short period of time. However, some rainshowers are light, but if it rains lightly all day long then the same amount of rain could possibly fall as during a short heavy thundershower. So, it's the intensity of the rainfall and the length of time that it rains that determines the total amount of rainfall. Photographic exposure works in the same way. In theory, a small amount of light striking the film for a long period of time will produce the same total exposure as a lot of light striking the film for only a short period of time. Therefore, one unit of light acting on the film for 100 seconds produces the same exposure as 100 units of light striking the film for one second.

Exercises (206):

1. What is the formula for photographic exposure?

2. What are the factors that determine photographic exposure?

207. Given a series of exposure settings, determine their equivalent exposures.

Exposure Controls. You are familiar with the water rushing from a faucet. As you open the faucet, more water comes out. If you close the faucet and make the hole smaller, less water is allowed to come out. On a camera you have essentially a faucet, called the diaphragm. The diaphragm can be made larger or smaller allowing more or less light to strike the film. In the exposure formula $E = I \times T$, the diaphragm controls (I) or intensity.

F/stops. In many cameras an iris diaphragm (fig. 2-1) is used to control light intensity.

This diaphragm consists of a series of overlapping leaves that form a circular opening between the lens and the film. The interlocking leaves are adjustable so that the size of the circular opening that passes light through to the film can be made larger or smaller.

An adjustable ring surrounding the lens barrel can be rotated to increase or decrease the size of the diaphragm opening. The numbers marked on this ring are called f/numbers or f/stops. When the diaphragm ring is moved to the smallest number (f/1.4 for example) the diaphragm is wide open, which lets through the maximum amount of light. Moving to a higher numbered f/stop decreases the size of the diaphragm aperture, thereby reducing the amount of light that can pass to the film.

Lens manufacturers have standardized f/stop scales starting with f/1 and progressing by the square root of 2 through the various full f/stops. An important advantage of this system is that each higher numbered f/stop reduces the intensity of the light striking the film by one-half. The term "full f/stop" is applied to the following f/stops: f/1, f/1.4, f/2, f/2.8, f/4, f/5.6, f/8, f/11, f/16, f/22, and f/32. The term "lens speed" refers to the largest aperture (i.e., the smallest f/number) of the lens.

The phrase "closing down a stop" means moving from one full f/stop to the next larger number, such as from f/11 to f/16. Doing this reduces the light intensity by one-half. Opening up one stop produces the opposite result. In this case, as you move from a larger number to the next smaller number (f/16 to f/11), the light intensity doubles.

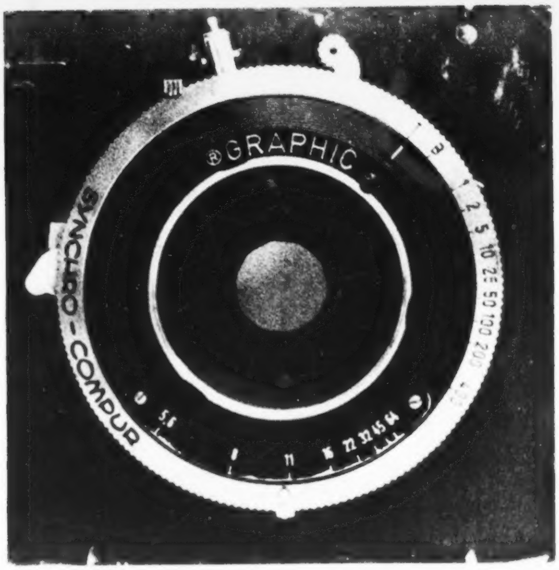


Figure 2-1. Iris diaphragm.

Shutter speed. The aperture can be changed by opening and closing the diaphragm. This is one exposure control. The other is the time you allow the light to strike the film. This is the (T) or time of the formula E = I × T. If you leave the faucet open for a long time, you will get lots of water. The same applies to the shutter. If you leave it open for a long time, you will get lots of light on the film.

The lens barrel is marked with numbers for the shutter speed. Normally, the shutter speeds are expressed as whole numbers; that is, 1/400 second is indicated by the whole number 400; 1/50 second, by 50; and so forth. When the shutter setting is B, the shutter is held open as long as the shutter release is held down. When the setting is T, the shutter is opened when the release lever is tripped and remains open until the lever is tripped a second time. (See fig. 2-2.)

Notice that for most of the shutter speed ranges, the speeds are graduated in multiples of 2. In general, each shutter speed will give an exposure duration that is approximately half the next lower setting or double the next higher setting. Most shutters are marked in a manner similar to this, although the range of speeds may vary.

Since both aperture and shutter speed settings can control exposure, it is possible to alter exposure by changing either the aperture or the shutter speed setting. As an example, if you want to double the amount of exposure for a certain film, you can open up the lens one f/stop, or you can double the exposure time by moving to the next smaller number.

The term "close down one stop" is also a short-hand way of saying, "Reduce your exposure by one-half." This reduction can be accomplished by doubling your shutter speed or using the next smaller lens aperture. Sometimes it may be to your advantage to change one rather than the other. For example, let's assume that you are photographing a subject and you have decided the correct exposure time is 1 second. You know that

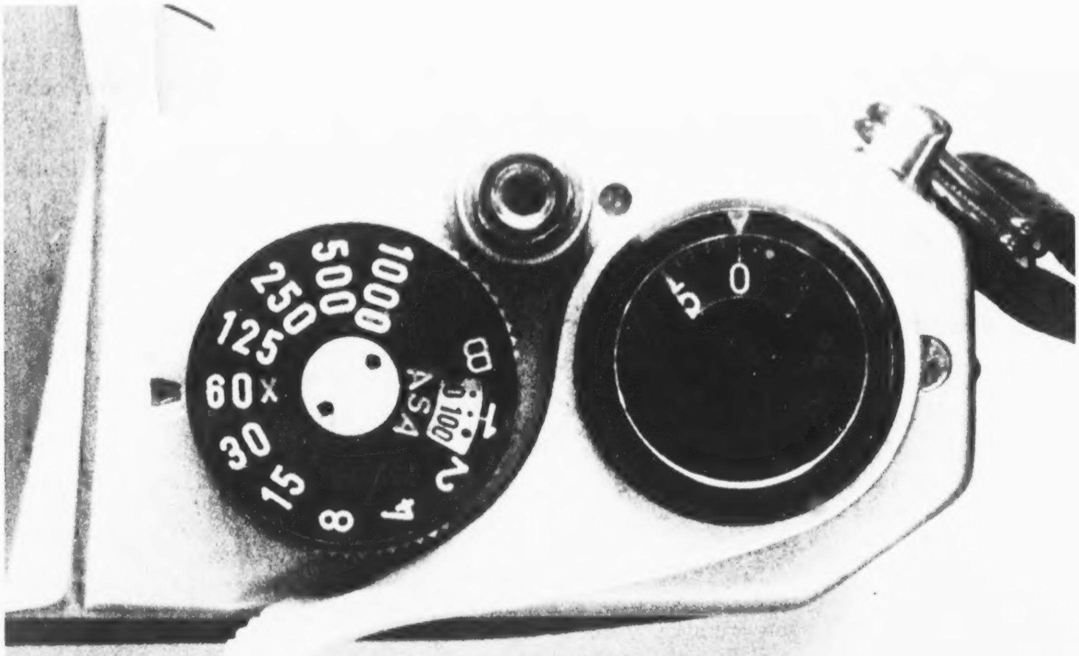


Figure 2-2. Shutter speed ring.

you can't hold the camera still for 1 second, so what do you do? Use an equivalent exposure.

Equivalent Exposures. This term applies to any combination of shutter speed and f/stop that will give a good exposure. Remember that as the f/stop goes from 11 to 16, you reduce the amount of light intensity by one-half. If you change your shutter speed from 1/100 to 1/50 of a second you have doubled the amount of time. Therefore, you should see that an exposure of f/11 at 1/100 is the same as f/16 at 1/50.

This is an easy method of setting equivalent exposures. As you move one setting one way (up), move the other one the other way (down). In other words, as your f/stop number gets larger, you must make your shutter speed number smaller. Consequently, as you change your f/stop to a smaller number you must change your shutter speed number to a larger number.

One more hint that may help: the higher the f/stop number, the smaller the aperture hole.

Exercises (207):

1. Select the equivalent exposure settings for each of the following.
   - a. 1/60 at f/8 is equal to:
     - 1/25 at f/11.
     - 1/30 at f/16.
     - 1/250 at f/4.
   - b. 1/250 at f/5.6 is equal to:
     - 1/250 at f/2.8.
     - 1/500 at f/8.
     - 1/60 at f/11.
   - c. 1/30 at f/11 is equal to:
     - 1/125 at f/8.
     - 1/60 at f/16.
     - 1/250 at f/4.

208. Briefly explain the law of reciprocity, the conditions under which there is likely to be a failure of reciprocity, and the effect of reciprocity failure.

Reciprocity Law. Earlier, we defined exposure as the product of the intensity of the light reaching the sensitized material and the time of exposure: $E = I \times T$. The amount of photographic chemical reaction, or silver image density, is dependent upon the exposure received by the film or paper. This equation ($E = I \times T$) is also known as the reciprocity law.

Applying the law of reciprocity, if no other factors are involved, you can expect the same density on two samples of sensitized materials having the same speed (assuming equal development), even though one sheet of the material is exposed to 500 units of light for 1 second and the other to 1 unit of light for 500 seconds. The product of the light intensity and the time of the light action is the same for each exposure.

Let's take another example. An exposure of 1/250 second at f/8 is equal to an exposure of 1/60 at f/16. In a practical sense, the reciprocity law holds true for the normal range of exposure time, but the normal range for various sensitized materials differs considerably. Many films have a normal range of 1 second to 1/500 second; others have a normal exposure range of between 1/10 and 1/1,000 second. Failure of the reciprocity law to apply in this normal range is insignificant, and you can disregard it for most practical applications of photography. This is why you can use published tables, exposure calculators, and exposure meters in most of your day-to-day photography.

Unfortunately, photographic emulsions do not always correspond to constant results obtained when light intensity and exposure times are widely varied. The reciprocal relationship of intensity and time as outlined in the exposure equation does not necessarily hold true in some applications. Actually, film is less responsive when it is exposed under extremely high or low light intensities as compared to exposure under medium intensities. Both extremes are usually marked by very short or very long shutter speed settings.

It is interesting to note that at both extremes the effect of reciprocity failure is an apparent loss of film speed. The loss of film speed results in an underexposed negative. The extent of speed loss varies with different emulsions under particular conditions, and no general rule can be given. Required exposure compensation for reciprocity failure must be found by experimentation for each emulsion. The best insurance against reciprocity failure is the use of the aperture, rather than extremes of shutter speeds, to control exposure.

Exercises (208):

1. Briefly explain the law of reciprocity.

2. Explain under what conditions there is likely to be reciprocity failure.

3. Explain the effect of reciprocity failure.

209. Define scene brightness range and briefly explain why the scene brightness range affects the information that is recorded on the film.

Scene Brightness Range. When viewing a typical scene, your eyes respond to the color of light reflected by each part of the subject. Your camera lens focuses this light upon the film and forms an image in natural color. However, black-and-white photographic films can only reproduce these colors in various shades of gray. The density of these various shades depends on the brightness of the reflectance of each subject color and the color sensitivity of the film. The relative difference between the brightest areas (highlights) and the darkest areas (shadows) is termed the scene brightness range (SBR).

Typical photographic scenes may have scene brightness ranges from 1:2 to well over 1:500. That is to say, by comparison, a shadow is 1/2 to 1/500 as bright as the highlight in the scene. Common film emulsions are capable of recording all of the extremely low scene brightness ranges, but few can record very high ratios of shadow to highlight brightness. The problem is compounded by typical printing paper emulsions that can only record tone differences of 1:30 or less.

Most films are properly exposed when the brightest highlight creates the greatest practical image density. This practical maximum occurs when 128 times the minimum amount of light strikes the average black-and-white film. At this point, we can say that the range of the particular film is 1 to 128. Any object reflecting more than 128 times the minimum amount of light will end up as a washed-out highlight.

When an original scene contains a greater brightness range than the film can capture (for instance, a scene brightness range of 1-to-600), photograph any slice of the scene that contains a 1-to-128 ratio of light units. You can photograph 2-to-256 light units or 4-to-512 units; any ratio that reduces to 1 to 128. Remember, any areas that reflect less light than our low point result in a clear negative, and areas above our high point result in a "blocked up" area of the negative.

Exercises (209):

1. Define scene brightness range.

2. Briefly explain why the scene brightness range affects what information will be recorded on the film.

2-2. Exposure Calculators

Now that you have examined the theories of light, light sources, and exposure, you must learn how to determine what exposure to use. In this next section we will discuss the methods of determining what shutter speed and aperture to use by employing different types of exposure calculators.

The problem of calculating the exposure for any subject involves the interrelation of two factors: the speed of the film and the brightness of the subject. We use the American Standards Assocation (ASA) film speed indexes for the exposure computation of speed. Two methods of judging brightness are visual estimation and the use of an exposure meter. Both have their individual merits; however, for consistent results under various conditions, only a properly working exposure meter should be used.

210. Given lighting and subject conditions, calculate the correct exposure using the exposure guide in figure 2-3.

Visual Estimation. Visual estimation is based on past experience with films of a given speed and personal judgment of scene brightness. Because of the characteristics of the human eye, such brightness judgments are seldom very precise, although experienced photographers can become quite skilled at making visual estimations under familiar conditions.

In the absence of an exposure meter, the following system can be used to calculate a fairly accurate camera exposure outdoors. The basic shutter setting is the reciprocal of the film speed. If the film's ASA rating is 125, use 1/125 second as the shutter speed; if the speed is 250, use 1/250 second; and so forth. Your basic f/stop setting can be selected by using an exposure table. Many film packages contain tables such as the one shown in figure 2-3.

Using an Exposure Table or Guide. Completely accurate assessments of lighting conditions are seldom possible. However, most film emulsions have sufficient latitude to cover any minor error you might make. Consider the following statements as aids in assessing light conditions by visual estimation.

a. A bright sun and clear sky produces deep dark shadows of subjects in the scene. Use the Bright Sun column for exposures under these conditions.

b. If the sun's outline is visible behind a thin veil of clouds, use the Hazy Sun column. In this case, the sun's brightness has been softened somewhat by a fine haze over the sky or by thin clouds. As a result, the shadows of objects are light and transparent.

c. If you can't see the sun and the sky is bright in the direction that the sun should be, use the Cloudy Bright column. Many overcast days when the sun is hardly visible can be included in this classification. Shadows of ground objects under these conditions are barely visible.

d. In the event the whole sky is covered with dark clouds, use the Open Shade column. This classification also applies when the subject is standing in the shadow of another object. By open shade, we mean it is possible to see the clear sky overhead from the subject's position. In other words, the subject is standing in the shade of another object, and this shade is fairly even over the entire area where the subject is located.

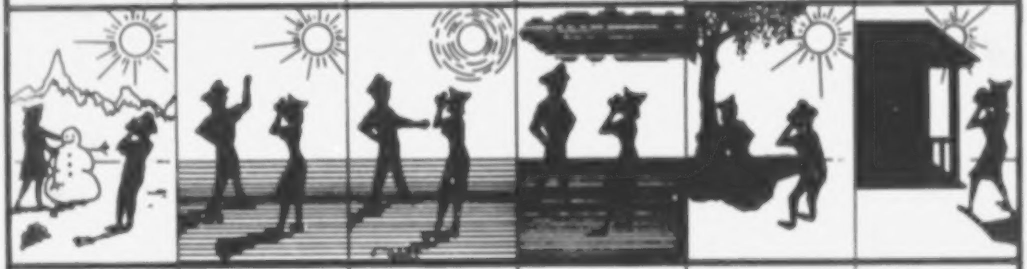
e. Use the Deep Shade column when supplemental lighting of subjects in deep shade is not possible. Use extra care in making photographs in deep shade to insure adequate shadow detail.

Next, turn your attention to the subject brightness. In a general snow scene or a beach scene with a lot of reflection throughout the entire area, use the top row labeled brilliant. If the main subject, within the snow or beach scene, is not reflecting very much light because the subject is dark colored, use the second row of f/stops labeled bright. Also, use the bright classification when you estimate that the general scene is reflecting more than 50 percent of the light striking it. Most of the subjects you will be photographing can be classified as average. This means that they reflect 15 to 50 percent of the light striking them. When it appears to your eye that the subject is reflecting less than 15

231-294

DAYLIGHT EXPOSURE TABLE

USE SHUTTER SPEED WHICH IS RECIPROCAL OF FILM SPEED



BRIGHT SUN ON LIGHT SAND OR SNOW	BRIGHT SUN SUBJECT IN DIRECT SUNLIGHT*	HAZY SUN SOFT SHADOWS	CLOUDY BRIGHT WITH NO SHADOWS	OPEN SHADE WITH CLEAR BLUE SKY	DEEP SHADE
BRILLIANT SUBJECT f/32	BETWEEN f/22 — f/32	f/22	f/16	f/11	f/8
BRIGHT SUBJECT f/22	BETWEEN f/16 — f/22	f/16	f/11	f/8	f/5.6
AVERAGE SUBJECT f/16	BETWEEN f/11 — f/16	f/11	f/8	f/5.6	f/4
DARK SUBJECT f/11	BETWEEN f/8 — f/11	f/8	f/5.6	f/4	f/2.8

* Note: For side or back-lighted subjects in bright sunlight, use ½ to 1 stop more exposure to record shadow detail.

Figure 2-3. A daylight exposure table.

percent of the light striking it, use the last row of f/stops labeled dark.

Let us try to put everything together by working a problem. Suppose you are photographing a cream-colored building. First, you look at the sky in the direction of the sun. You discover the light condition to be "hazy sun" since you are able to see the outline of the sun through a thin veil of clouds. Since the building is cream colored, you then select "bright" for the subject brightness. At the point on the table where the columns for bright subjects under hazy sun intersect, you find f/16 to be the basic aperture setting. If you are using film with a speed of 125, the basic exposure would be 1/125 at f/16.

Exercise (210):

1. Using figure 2-3, select the appropriate f/stop for each one of the following shooting situations.
   a. Photographing a snow scene on a day when the sun has been softened by thin clouds.

   b. The subject is a black automobile. The sky is overcast.

   c. Photographying a young girl under a tree on a sunny day.

211. Calculate the proper exposure and distance using flash guide numbers.

Flash Guide Numbers. Data guide charts are fine for most outdoor subjects but suppose you are inside and want to use your electronic flash. We have guides for this too; they are called guide numbers.

Guide numbers are relative numerical values that correspond to the light output of the electronic flash unit. Basic guide numbers are established by the manufacturer of the flash unit. You can find the guide numbers for your particular flash unit from the owner's manual for the flash.

The exposure for flash photography is based on the output of the flash and the distance between the subject and the flash. Guide numbers provide a simple mathematical method of determining the proper f/stop. For example, suppose you are using a flash unit with a guide number of 160 and the flash is 10 feet from the subject. To find the proper f/stop, divide the distance (10) into the guide nubmer (160). The quotient (16) determines that f/16 will give you the proper exposure. NOTE: Shutter speed is not used in figuring your electronic flash exposure because the duration of the flash is, in effect, the shutter speed.

Suppose you want to use a particular f/stop. The guide number then helps you decide how far from the subject to place your flash unit. For example, you want to use f/8 and your guide number is 64. In this case, divide the f/stop (8) into the guide number (64) and you will find that to use f/8 you need to put the flash 8 feet from the subject.

Synchronization. One more consideration for flash photography is synchronization (sync). That is, the flash must light at the same time the shutter is open. If the flash and shutter are not synchronized, you may get only part of a picture, or even no picture.

Exercise (211):

1. Solve the following flash exposure problems.

	Guide Number	*Flash-to-Subject Distance*	*f/stop*
a.	160	10 ft.	
b.	220		f/22
c.	80		f/8
d.	64	8 ft.	

212. Exemplify the proper uses of exposure meters.

Exposure meters are light-sensitive measuring devices which convert light energy into electrical energy on a proportional basis. Available light exposure meters employ two systems for making light intensity readings. The incident method measures the intensity of light falling on the subject. The reflected method measures the amount of light reflected by the subject. For the sake of discussion, we will examine each method separately.

Incident Light Meters. The incident light meter measures the light falling on the subject. This type of meter does not consider the tone value of the subject at all. Thus, it does not read the amount of light that is reflected by the subject. When using this type of meter, take into consideration the tonal value of the subject to determine the scene brightness range.

Many of the modern exposure meters can give incident or reflected light readings. Photoelectric exposure meters operate on a common principle and, as shown in figures 2-4 and 2-5, vary primarily in their configuration for use. Light falls on a photoelectric cell that creates an electrical current. The cell produces power in direct relation to the intensity of the light it receives, and moves a needle that indicates light intensity on a scale for exposure computation. The more light there is, the greater the deflection of the needle. In addition, the meter has a set of dials that, when set according to the proper film-speed index and the scale reading of light intensity, gives the exposure directly, depending on the shutter speed or diaphragm opening desired.

Figure 2-4 shows the incident-light sphere that gathers light for the photoelectric cell. The sphere receives the light from above, below, the front, and the sides. When held at the subject position and pointed toward the camera (as in fig. 2-6), the incident-light meter measures the light falling on the subject.

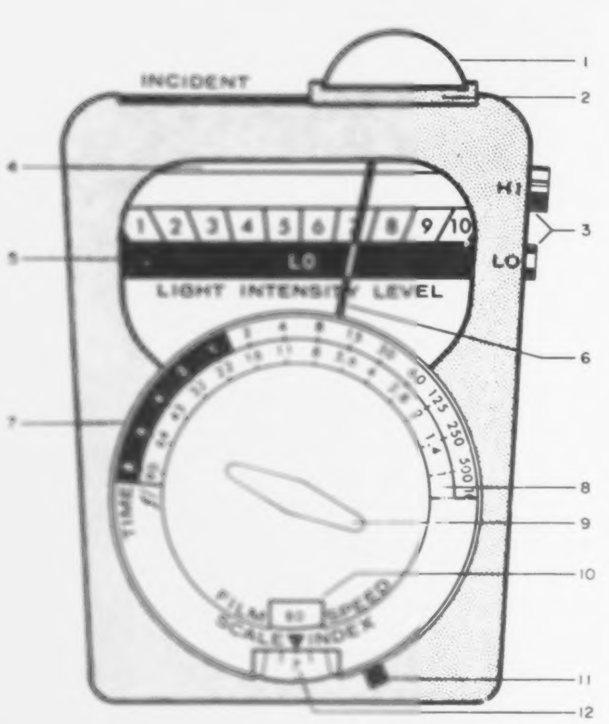
When using an incident light meter, point the light-gathering receptor toward the camera. The meter averages all of the light falling on the subject. This type of metering is valuable when you have contrasting or back lighted subjects where the strong highlights might cause erroneous reflected readings.

Reflected Light Meters. A reflected meter is used to measure light that is being reflected by the subject toward the camera. The meter is programmed to yield a reading that will reproduce a middle gray tone. If you measure the light being reflected by a certain subject, use this reading for your exposure, and then process and print your film correctly, the subject will appear a medium gray. All other parts of the scene that reflected more or less light than this subject will be lighter or darker than middle gray. It is most important to realize a middle gray tone may not be the best representation of the subject, and you may have to modify your exposure to achieve the right one.

Figure 2-7 illustrates the principle of reading with the reflected light exposure meter. It measures the amount of light being reflected toward the camera by the subject. Thus, this type of meter actually measures the picture-producing light. This is the most important feature of this type of light meter. Use this meter to measure the scene brightness range by taking separate readings of the highlight and shadow portions of the subject.

When taking a reflected light reading, it is important to know exactly what part of the subject the meter is reading. Each type of meter has its own angle of acceptance. Some meters read a very narrow area (such meters are often called "spot" meters) while others read a very wide angle. Sometimes, a meter will read too much of the shadow or highlight areas and cause an inaccurate exposure. Therefore, it is a good idea to move in close to the subject so that you can make sure that the main subject is being measured.

There are basically three types of readings made with a reflected meter: (1) average, (2) brightness range, and (3) substitute. Let us see how each works.


INCIDENT
1
2
4
5
3
HI
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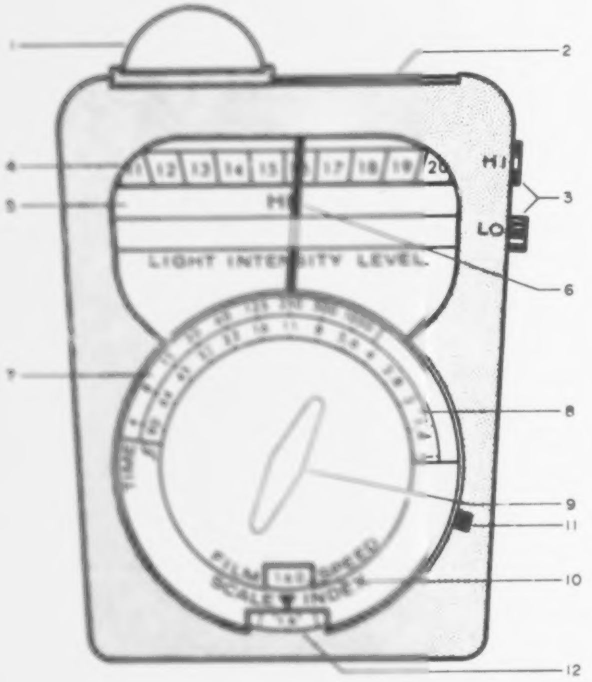
1 2 3 4 5 6 7 8 9 10
LO
LIGHT INTENSITY LEVEL
6
7
TIME
f/
8
9
10
FILM SPEED
SCALE INDEX
11
12

1 INCIDENT LIGHT SPHERE
2 REFLECTED LIGHT APERTURE (COVERED BY SPHERE)
3 ILLUMINATION SELECTOR BUTTONS
4 HIGH INTENSITY ILLUMINATION SCALE (OUT OF VIEW)
5 LOW INTENSITY ILLUMINATION SCALE
6 SCALE INDICATOR NEEDLE
7 EXPOSURE TIME SCALE
8 LENS APERTURE SCALE
9 FILM SPEED SELECTOR
10 FILM SPEED INDEX WINDOW
11 INTENSITY SCALE INDEX LEVER
12 INTENSITY SCALE INDEX WINDOW

231-292

Figure 2-4. A hypothetical exposure meter set for incident light.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11 12 13 14 15 16 17 18 19 20
HI
3
HI
LO
LIGHT INTENSITY LEVEL
6
7
TIME
8
9
11
FILM SPEED
SCALE INDEX
10
12

1 INCIDENT LIGHT SPHERE
2 REFLECTED LIGHT APERTURE
3 ILLUMINATION SELECTOR BUTTONS
4 HIGH INTENSITY ILLUMINATION SCALE
5 LOW INTENSITY ILLUMINATION SCALE (HIDDEN)
6 SCALE INDICATOR NEEDLE
7 EXPOSURE TIME SCALE (ROTATES WITH INTENSITY SCALE INDEX)
8 LENS APERTURE SCALE (FIXED)
9 FILM SPEED SELECTOR
10 FILM SPEED INDEX WINDOW
11 INTENSITY SCALE INDEX LEVER
12 INTENSITY SCALE INDEX WINDOW

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Figure 2-5. A hypothetical exposure meter set for reflected light.

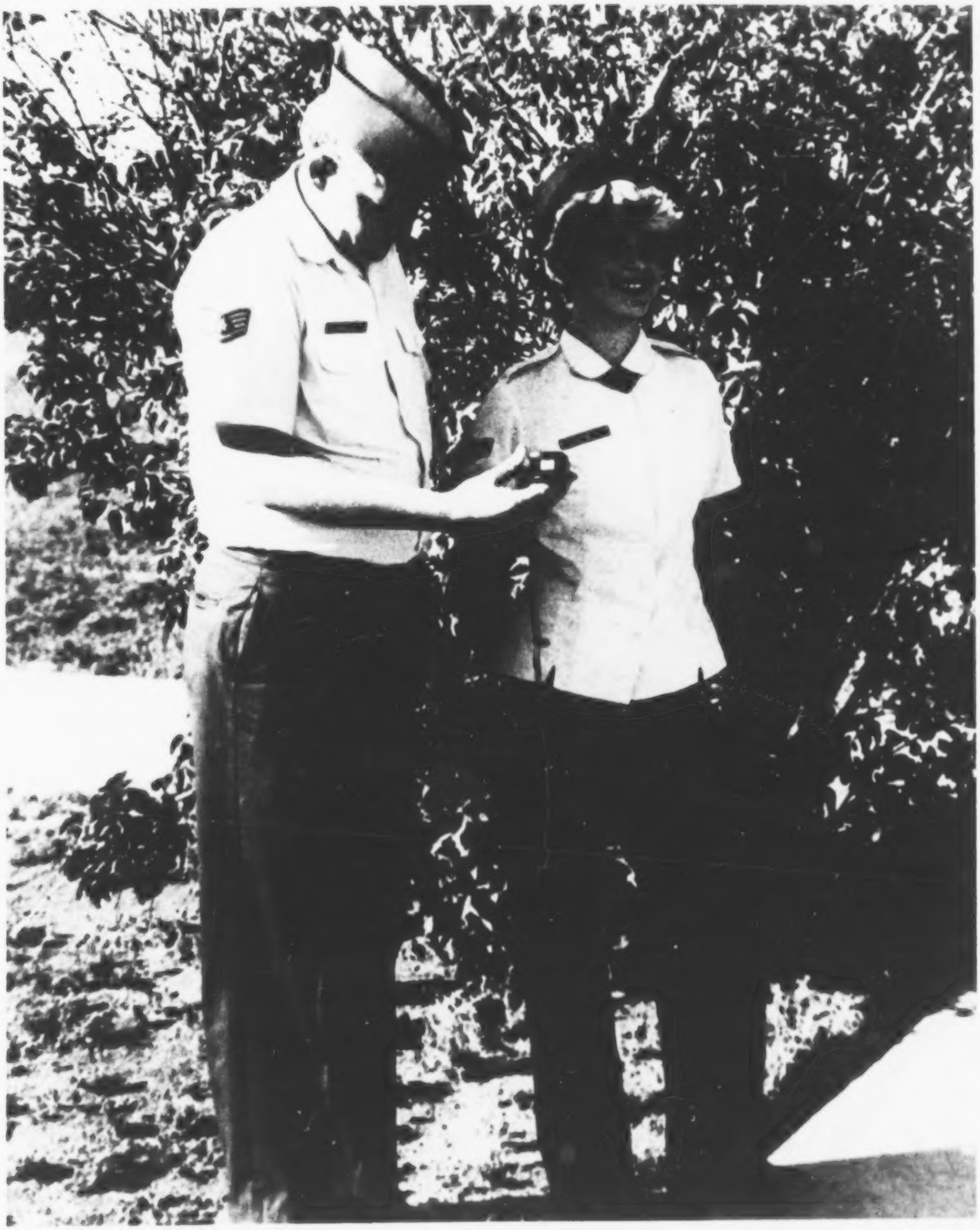

Figure 2-6. Taking an incident meter reading.

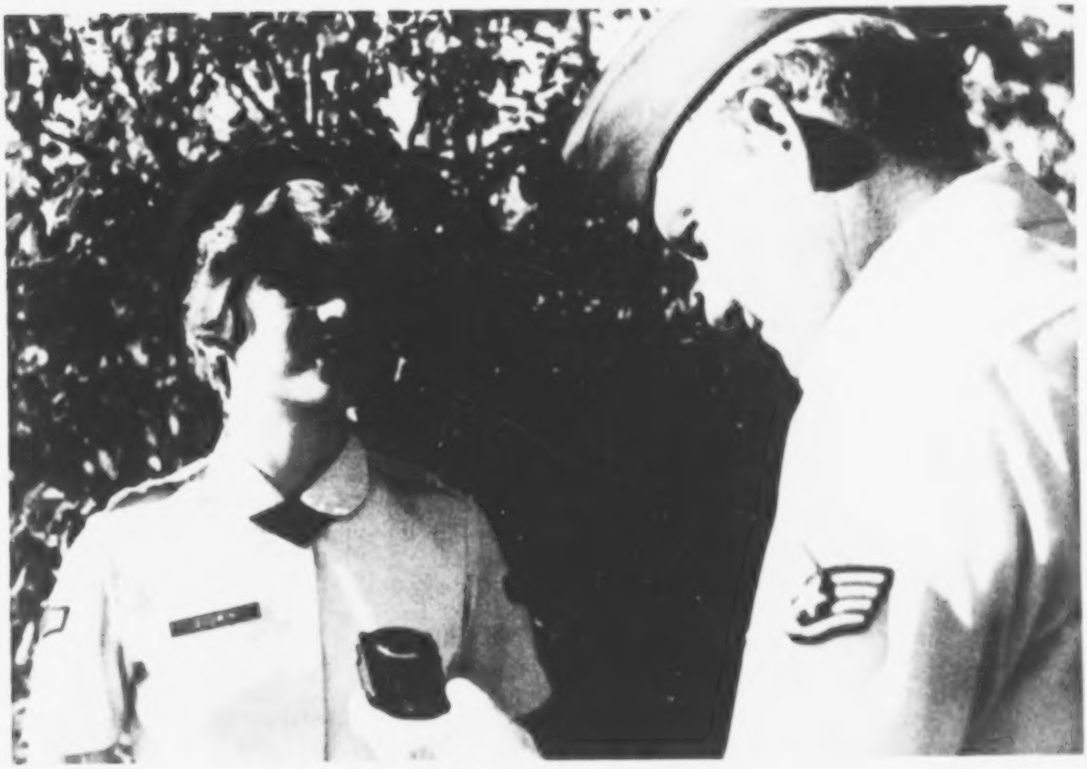

Figure 2-7. Taking a reflected meter reading.

Average reading. To take an average reading, you simply aim the meter toward the middle of the subject and take a reading. This averages the highlight and shadow areas to give you a "middle" reading. This type of reading works well with average contrast subject.

Brightness range. To take a brightness range reading, you first take a reading of an important highlight area. Next, take a second reading by measuring an important shadow area. Then average these two readings to get your exposure. For example, if the highlight measured f/22 at 1/125 and the shadow was f/5.6 at 1/125, your exposure would be f/11 at 1/125.

Substitute reading. If you cannot approach the subject to measure its reflectance, you can select some object that closely approximates the subject's reflectance and use it to compute exposure. If the substitute object is lighter or darker than the subject, you must make a minor adjustment before making the exposure. For example, if the subject is a person you could take a reading off the palm of your hand and use this reading to produce a good exposure. Remember, the substitute object must be illuminated by light having the same quality and intensity as that used to illuminate the subject.

Flash Meters. A flash meter, as shown in figure 2-8, allows you to determine the proper exposure for flash photography. We told you about guide numbers earlier, which are adequate, but for more precise measurements use a flash meter. A flash meter also enables you to establish your own guide number for each flash unit.

Flash meters measure the incident light coming from the flash units. You use a flash meter by placing it at the subject position and pointing it at the camera. Trip the flash and you get an immediate and accurate flash exposure reading. One of the greatest advantages of a flash meter is that you can easily compute exposure when using more than one flash unit or "bounce" flash.

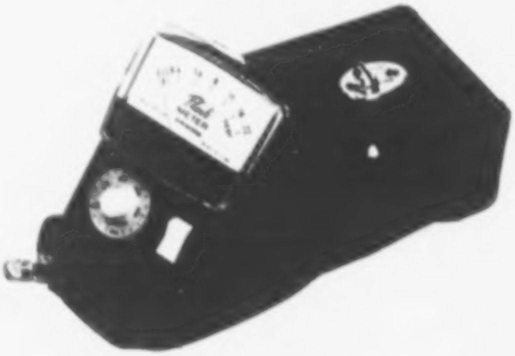

Figure 2-8. A flash meter.

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Exercise (212):

1. Answer the following statements true or false, and correct the false statements.
   a. Incident light meters measure the light falling on a subject.
   b. Incident light meters automatically allow for the tonal differences in the scene.
   c. Point an incident light meter at the subject to get your exposure setting.
   d. A reflected light meter measures the light bouncing off of the subject.
   e. Many light meters can measure both reflected and incident light.
   f. You must use a separate flash meter for each flash unit.
   g. Use a flash meter at the subject position and point it at the camera.

213. State the proper use and care of an exposure meter.

Care of Exposure Meters. Your exposure meter will last for a long time if you don't drop it or otherwise abuse it. To insure utmost accuracy, you should follow the appropriate operator's checklist and instructional booklet provided by the manufacturer. You should also consider the following points:

(1) Clean the glass over the photoelectric cell before use. (NOTE: In dry weather, you may find that rubbing the glass with cloth can generate a static electricity charge and cause the needle to give a false reading. You can remove the charge by breathing on the glass.)

(2) Zero the meter. Cover the meter cell opening to cut off all the light. (With some meters you must remove the batteries.) The needle should be at 0 or at an appropriate zero mark. Tilt the meter in various directions—from side to side and up and down. The needle should not move more than the equivalent of one-third of an f/stop despite the position of the meter. If needed, adjust the needle until it zeroes.

(3) Check for sticky movement. Aim the meter cell at any light source until the needle is at about the halfway mark on the scale. Cover the cell and uncover it several times. The needle should go to 0 each time the cell is covered. Even with low light intensity, the meter pointer should move smoothly.

(4) Check for accuracy. Absolute accuracy tests are very difficult, and it is impossible to check for the meter's accuracy every time you go on a camera mission. However, be sure the meter indicates exposures that are logical on the basis of your experience or that match those indicated by another meter of known accuracy.

Always handle your meter correctly since the quality of your photographs depends on correct exposure metering. Consider the following operational DOs and DON'Ts.

DO—Protect the meter from bumping against other objects. Carry the meter in your pocket or camera case when it isn't in use. The meter case gives some protection, but is not adequate for safety in extreme conditions.

DON'T—Subject the photoelectric cell to light intensities above those that are programmed by the selector switch. Extreme intensities may cause the indicator needle to bounce at the high end of the scale and eventually cause damage to the unit.

DON'T—Subject the exposure meter to temperatures above 125° F. (51.7° C). When you are not using the meter, keep it in the carrying case and away from heat.

DON'T—Point the photoelectric cell toward the sun. The cell may be "blinded" and give erroneous readings for many hours.

Exercises (213):

1. How do you zero an exposure meter?
2. Can subjecting a meter to very high intensities of light cause permanent damage? Explain briefly.
3. What should be done with the meter when it is not in use?
4. What will blind the photoelectric cell?

214. Identify characteristics and describe the proper uses of the gray card.

Neutral Density Gray Card. There are times when the subject is so small that it is impossible for adjacent areas to be excluded from the exposure meter's field of

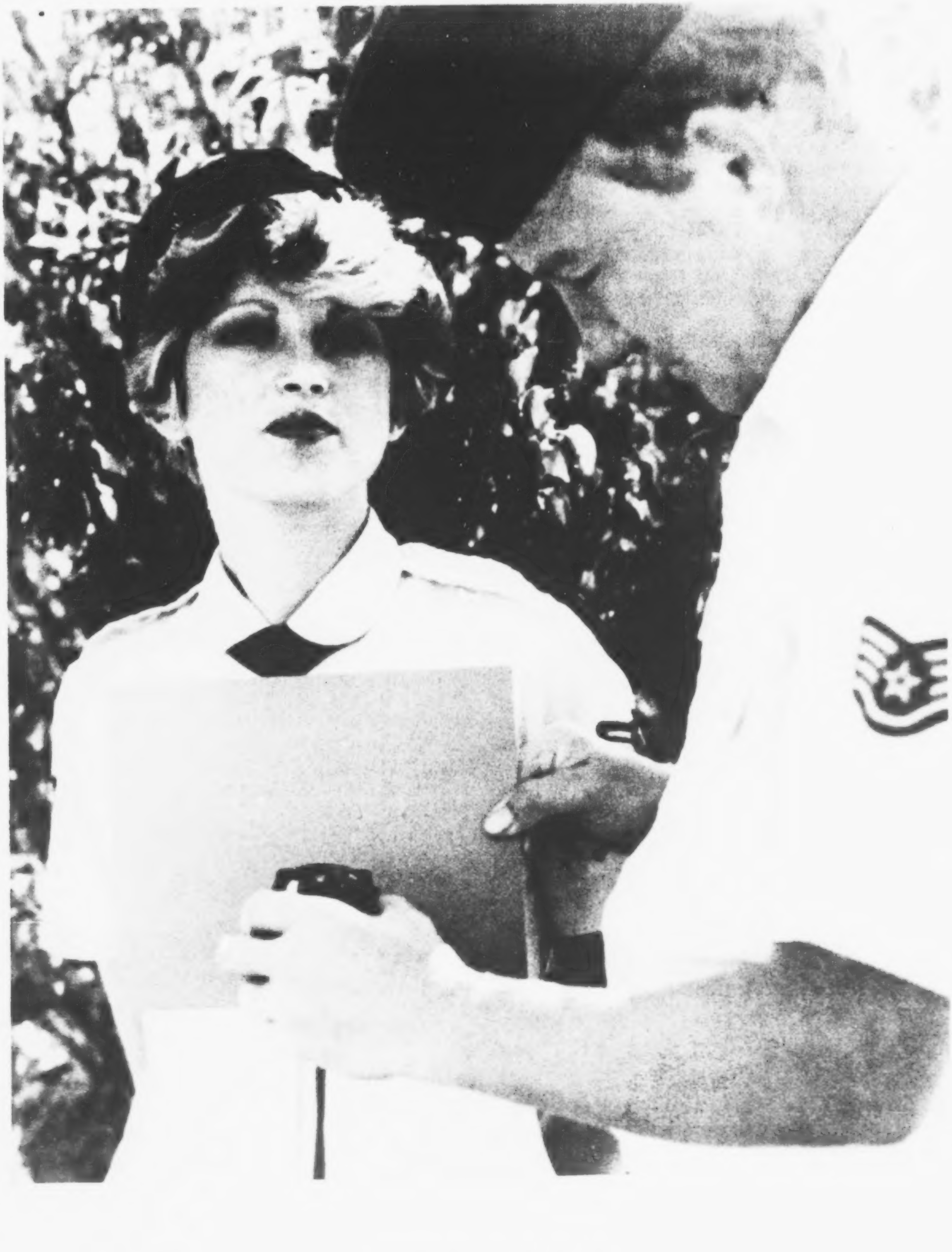

Figure 2-9. Using the gray card.

view. Under these conditions, the meter may provide inaccurate exposure data. At other times, it is impossible to approach the subject in order to take a meter reading. Also there are situations when the subject is not available for you to make exposure readings. For example, it is not possible to interrupt sports activities in order to take a closeup reading. Under these and other conditions, a neutral test card can be substituted for the subject to assist you in calculating the correct exposure.

The neutral-test card is approximately 8 x 10 inches (20 x 25 cm) in size, gray on one side and white on the other. The gray side reflects 18 percent of the light incident on it, while the white side reflects 90 percent of the light that strikes it.

There are three basic rules to be remembered when using a gray card:

(1) The illumination falling on the card must be of the same quality and intensity as that falling on the subject.

(2) When you are using a gray card to estimate exposure, be sure to hold the meter close to the card. This way, light from surrounding areas will not strike the meter's cell and produce erroneous readings.

(3) Make sure that the card is held perpendicular to the ground. If it is held at an angle, either up or down, it will produce inaccurate readings.

To use the gray card correctly, position it properly as shown in figure 2-9 and measure the light reflected from it. Next, compare the reflectance of the card with the reflectance of your subject. If the subject is lighter, select a smaller aperture; if the subject is darker, open the aperture to admit more light.

When working under conditions of extremely low illumination, it may not be possible to register a reading on the gray side of the card. However, the white side of the card reflects five times as much light and may provide sufficient reflectance to make an exposure reading. If the white side of the neutral test card is used, you must remember that it shortens the exposure by five times over the reading provided by the gray side of the card. Typical subjects reflect less light than the white side of the neutral test card. If you use the actual exposure data provided from this side of the card, most of your negatives will be severely underexposed.

As a general rule, open the aperture approximately 2½ f/stops over the white side reading. Another way of compensating for the white side of the test card is to divide the ASA by 5, then use that number on the light meter instead of the real speed index number. This will give you the proper f/stop.

Exercise (214):

1. Identify each of the following statements as true or false, and correct the false statements.
    a. The gray side of a neutral test card reflects 18 percent of the light striking it.
    b. You can take an incident reading off a gray card.
    c. When using the white side of the neutral test card, you need to increase your exposure 2½ f/stops.
    d. When taking a reflective light reading off a gray card, the card should be held at a 45° angle to the subject.

Sensitized Black-and-White Materials

THIS CHAPTER will acquaint you with the physical structure and emulsion characteristics of black-and-white film. There are many types of black-and-white sensitized materials (film) available and some of the differences between these films are very important. Quality photographic results depend on knowing and taking advantage of these differences. When you are aware of the differences in various types of film, you can make an intelligent choice to obtain a desired result. Even with the simplest of cameras, a change in film may improve the final product.

3-1. Structure and Characteristics

All conventional photographic films consist of several layers and each layer serves a specific function. These layers are: the overcoating, emulsion coating, substratum coatings, film base, and antihalation backing. Refer to figure 3-1 as we discuss the function of each of these layers.

215. Describe the functions and characteristics of various layers in the structure of film.

The Overcoating. The overcoating is a thin layer of gelatin that protects the emulsion beneath it during normal handling and use of the material. Without this protective overcoating, the mere act of placing sheets of film on top of one another could cause minor scratches and abrasion marks that would show up after processing. However, this overcoating does not protect the emulsion from rough or abusive handling.

The Emulsion Coating. The emulsion coating is the light-sensitive layer consisting of millions of microscopic silver halide particles imbedded and suspended in gelatin. The characteristics of the emulsion are determined by the kind and combination of silver halides, the size of the silver halides, how evenly they are distributed in the gelatin, the addition of dyes and other chemicals in the emulsion, and the quality of the gelatin itself. The emulsion, therefore, gives the film its basic characteristics.

The Substratum Coatings. The emulsion gelatin containing the light-sensitive particles does not adhere to the base without some kind of bonding material. A coating, spread over the base, bonds the emulsion to the base. There are two coatings—one on each side of the film base. The bonding coat is a very exact formula consisting of a cellulose acetate solvent, gelatin, and a gelatin solvent. These bind both the emulsion coating and the antihalation coating firmly to the film base.

The Film Base. At one time the only support used for film emulsions was glass. But since glass plates were heavy, bulky, and easily broken, photography was limited to professional use. (Glass plates are still used in many scientific applications of photography.) Eventually, research proved *cellulose nitrate* to be a suitable base material for the emulsion layer. It was light in weight, chemically inert (not affected by processing), transparent when free from impurities, and flexible (characteristics essential for common films). However, it had the tremendous disadvantage of being flammable. It would burn with almost explosive force. Film manufacturing has now progressed to give us fire-resistant plastic base materials, such as cellulose acetate, with great resistance to shrinkage and tearing.

The Antihalation Backing. The antihalation backing is usually a layer of dyed gelatin on the back side of the film. This backing serves two purposes, one is to counteract the curling tendencies of the film due to the contraction of the emulsion layer when it sets and dries. This helps the film lie flatter in the sheet film holders and also makes it easier to handle when printing. The other purpose is to absorb as much light as possible that goes through the film during the exposure. This light would otherwise be reflected back into the emulsion layer causing a halo around the images of brilliant subjects. Such unwanted effects are called *halation*.

Black antihalation dyes are more effective than dyes of other colors, but normal processes make their use impractical. Ordinary processing solutions are unable to destroy the black dyes which have been discovered so far. (There is an exception in the graphic arts field that requires a special developing solution.) Until a black dye is developed that can be destroyed in the processing solutions, we must use dyes of a color to

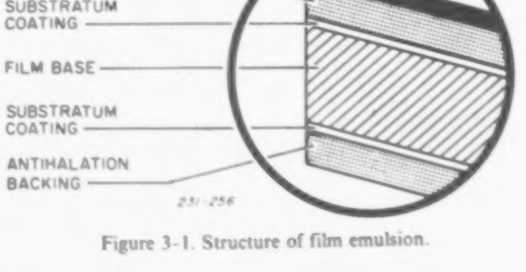

Figure 3-1. Structure of film emulsion.

which the film is least sensitive, or use a dye that absorbs as much as possible the unwanted light that causes halation.

Exercise (215):

1. Complete the following statements regarding the structure of film.
   a. The ______ protects the film from minor scratches.
   b. The photographic image is formed in the ____________.
   c. There are ____________ substratum coatings.
   d. Glass and cellulose acetate are materials that can be used to make the ______ ______.
   e. The antihalation backing is used to prevent ______ and ______.

216. Complete sentences about film grain size.

Grain. A photographic emulsion contains microscopic particles (grains) of silver halide. Because of certain processes during manufacturing, these grains have a tendency to clump together. This clumping characteristic determines the inherent (natural) size of the grain in any film.

High-speed (very sensitive to light) emulsions generally have a larger grain than slow-speed emulsions. The tendency of a particular film to produce a certain size of grain is called the inherent grain size.

Although inherent grain size influences the graininess of the image, processing also has a great effect in the control of graininess. By special processing techniques, it is possible to prevent the silver grains from excessive clumping during processing. When the grain becomes apparent in the image, it is objectionable.

When a print is made, it sometimes has a grainy appearance, especially in the large middle tone areas. Graininess also happens when large prints are made from small negatives. This is ~~called~~ caused by the granularity of the film being printed. Thus, the grain structure of the film influences the final product and therefore must be considered.

Remember, the faster the speed of the film, the more uneven is the distribution of large and small crystals of silver halide in the emulsion. The silver halides, when developed, form little threads of metallic silver that reach out into the surrounding gelatin. The overlapping of these silver threads gives the appearance of clumping and grain. Figure 3-2 shows a comparison between a slow and fast film as if you were looking at them edgewise through an electronic microscope. Notice how the evenly distributed silver halides in the slow emulsion do not cast shadows on each other so readily at each level; and since the clumping of grain is not apparent in the structure of this emulsion, it is called "fine grain."

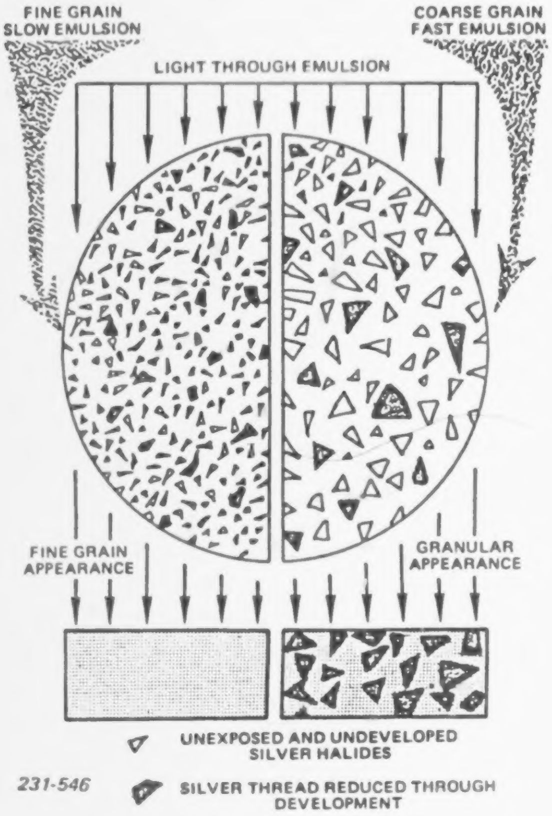

Figure 3-2. Size of silver halides.

Exercise (216):

1. Complete the following statements regarding film grain.
   a. Grain size is determined to a large degree by the choice of ______ and the type of ______.
   b. In a print, the grain will appear most prominently in the ______ ______.
   c. Fine grain films have ______ film speeds and very ______ distribution of silver.

217. Define terms and state factors relative to the sensitivity of film.

Sensitivity. The many and varied applications of light-sensitive materials are due to the behavior of the individual silver particles (silver halide crystals) that are suspended in the emulsion. The silver halides in negative materials are extremely sensitive to light.

The normal sensitivity to light of a silver halide in an ordinary prepared emulsion is the ultraviolet, violet, and blue wavelength range. No silver halides are sensitive to green, yellow, and red. Consequently, the pure silver halide emulsions are termed "blue sensitive." They reproduce colored objects in a different tonal brightness range than seen by the eye.

The addition of sensitizing dyes (cyanides) to ordinary silver halide emulsions increases their sensitivity to approximately the same spectral region as that of the eye. Increasing the emulsion's light sensitivity by dyeing (staining the silver halide crystals) is called optical sensitization. The increased sensitivity gained through the normal emulsion ripening process should not be confused with optical sensitization, since the later is only the spectral sensitivity of the silver halides. Optically sensitized emulsions are prepared by adding the sensitizing dyes in solution to the ripened emulsion just prior to coating it onto the base.

When the pure silver halide emulsions are exposed to long wavelength radiations, (green, red, and infrared), they do not react to any developable degree, and no change is brought about in the silver halide crystals. The function of the sensitizing dyes is to absorb the longer wavelengths of light and to transfer the effect to the silver halide. This produces the same action as direct absorption of light.

Color sensitivity is a very important characteristic of negative materials. Since it determines to a large extent the tones in which colored objects are reproduced, it is most important to know the color sensitivity of various light-sensitive materials. Figure 3-3 graphically illustrates the sensitivity of black-and-white negative material to different wavelengths of light.

The normal human eye response to light begins in the violet region and extends through blue, green, and red regions. However, the sensitivity of the eye is not the same for all wavelengths. Part A of figure 3-3 is a graphic curve that represents the relative response of the eye. It shows that the eye has maximum sensitivity in the blue-green and yellow-green portions of the curve.

Compared to the eye, films may respond differently to light. Negative emulsions are classified into four general types according to the way they render color differences as brightness differences. These four classifications are: blue sensitive, orthochromatic (sensitive to blue and green), panchromatic (sensitive to all the visible colors), and infrared emulsions (sensitive to blue, red, and part of the longer wavelengths beyond red). All silver halides are sensitive to ultraviolet radiation.

Exercises (217):

1. All silver halides are sensitive to what wavelengths of light?

2. Define optical sensitization.

3. What type of film has color sensitivity similar to that of the human eye?

218. Identify film latitude with particular film characteristics.

Latitude. The ability of a film emulsion to record a range of subject brightnesses (range of reflected light from the highlights through the shadows) is called film latitude. The range of brightnesses appearing on a negative or a print as shades of gray may be very great. An emulsion that is capable of rendering a long range of brightness values with satisfactory tone separation, has wide latitude. Conversely, if an emulsion can produce only a short range of brightnesses, it has narrow latitude. These differences in film performance determine the film's inherent latitude.

Inherent latitude is often considered to be an exposure safety factor. The extent that the exposure can be changed from normal, still giving an acceptable image, is known as exposure latitude. Exposure latitude is directly proportional to film latitude. If you have film with wide latitude, you have wide exposure latitude. In general, latitude in black-and-white films is related to film speed, with the faster speed films having the greater latitude. Exposure latitude permits you to use several possible exposures and still render printable negatives. As long as the range of tones in the scene maintain their same relationship, exposure's latitude is correct.

Exercises (218):

1. Define film latitude.

2. Exposure latitude is directly related to what factor?

3. Latitude in black-and-white film is related to what film characteristic?

219. Identify procedures for determining film speed and general characteristics of film speed.

Speed. Film speed is a term that is sometimes misunderstood. Simply stated, however, it means that some films are affected by light much more quickly than others. Film manufacturers have assigned a speed number to each film. The higher this number, the faster the film. The biggest advantage of knowing the film speed number is that it allows you to make a comparison between the speed of one film and another. For example, if a film has a number double that of another, it means that it is twice as fast. Or stating the idea another way, it means that only half the amount of light is required to affect the faster film to the same degree.

Emulsion speed is of practical importance because it has a direct bearing on the exposure required to produce a good image. To assist you, all exposure computing devices, whether they are exposure meters or guides, use the film speed number system. The American National Standards Institute (ANSI) establishes procedures for determining the speed of sensitized materials so that rating systems are standardized. The manufacturer's data sheet includes the speed rating expressed in terms of ASA.

The silver halide grains in a photographic emulsion are of varying sensitivity. Large grains are highly sensitive, while the smaller grains are less sensitive to light. In a high-speed film, the emulsion contains a high proportion of the larger, more sensitive grains. In a slow-speed film, the high proportion of small silver halide grains make the film less sensitive to light.

If a given area on a piece of film is exposed to light for a very short time, only the more sensitive grains are exposed, and the area is pale gray after development. If this is a fast film, it includes more of the sensitive grains, and the result is a darker shade of gray after development. Therefore, with a given amount of light and the same development, the faster film always

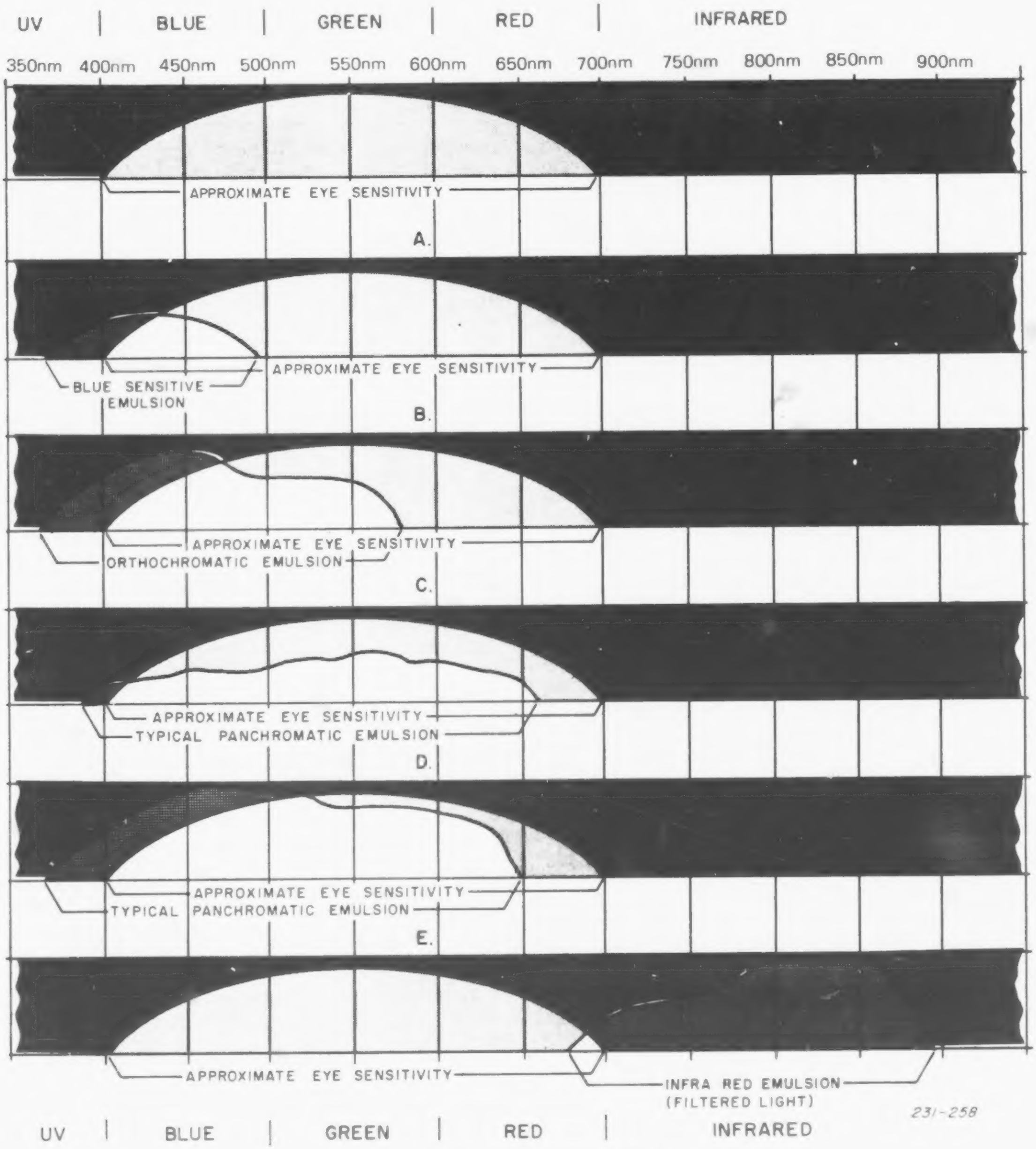

Figure 3-3. Color sensitivity of films.

produces a darker shade of gray (greater density) than the slower film, since a greater percentage of silver halides have been exposed and developed.

The practical application of a film speed number is rather simple. Let us assume that you have been using a particular film for a considerable length of time. Through your experience in taking photographs with this film, you have found that when photographing a brilliant subject under daylight lighting conditions, the correct exposure is 1/125 of a second at f/16. This film has been rated at a speed of 125. Now suppose under the same circumstances you want to use a film with a speed of 250. What does this number mean to you? It simply means that the new film is twice as sensitive to light as the old one. To compensate for this increased sensitivity, you could adjust either or both the camera's shutter speed or diaphragm to make the necessary correction. The new exposure for this film could be 1/125 at f/22, 1/250 at f/16, or 1/500 at f/11.

The film speed published by the manufacturer is usually computed for average conditions. You should, however, adjust the number according to your particular working methods and equipment, which becomes necessary when you consistently get overexposed or underexposed negatives.

Choose your mission film with its speed in mind. Generally speaking, select the slowest speed film that will accomplish the mission objective. Slower speed film has finer grain and resolving power (sharpness). The amount of light available at the scene and the particular shutter speed or f/stop desired also dictate the choice of film speed. For example, a portrait is normally shot with a wide aperture to reduce depth of field (area of sharpness). Choosing a fast film for an outdoor portrait on a sunny day would limit you to fast shutter speeds and small apertures. Conversely, under low-light conditions where wide exposure latitude is necessary, or on an airborne mission where fast shutter speeds are desirable, a high-speed film is ideal.

Exercises (219):

1. What is the organization that establishes procedures for determining film speed?

2. Complete the following statements in regard to film speed.

   a. Knowing your film speed number is essential in calculating your photographic ______ .

   b. A film with an ASA of 400 is twice as sensitive to light as one having a rating of ______ .

   c. Given the same exposure and development, the faster speed film produces the greater ______ .

   d. As a general rule, you should choose the ______ speed film that will accomplish the mission.

   e. In sunny conditions, a ______ speed film gives you a wider choice of apertures and shutter speeds.

220. Define film contrast and state selected factors and characteristics related to it.

Contrast. Another factor in selecting film is the inherent contrast of the emulsion. Film development, subject lighting, inherent or built-in film contrast are all contrast determining factors. Photographic emulsions, in varying degrees of inherent contrast, from very low to very high, are available. Your choice of emulsion contrast is influenced by the nature of the subject and whether it is desirable to decrease, maintain, or enhance contrast. It is, therefore, important to choose your film with its inherent contrast in mind.

Negative density is the result of exposure and development. The difference between the high and low densities of the various areas of the emulsion is called contrast. A bright area of the subject reflects a great amount of light that produces a correspondingly heavy density in the negative (highlight). A dark area reflects little light, resulting in a correspondingly thin density (shadow) in the negative.

The subject brightnesses in between these light and dark areas register as various densities called middle tones. The difference in brightness, from the brightest highlights to the deepest shadows, is the contrast. Normal contrast is represented by a full range of densities, including highlights, middle tones, and shadows. High contrast does not have a full range of densities, it consists primarily of highlights and shadows with little or no middle tones. Low contrast has very little density differences.

Emulsions are manufactured with varying degrees of inherent contrast for different applications. High-contrast (process) film is used to copy high-contrast black-and-white subjects, such as line drawings. Medium and low-contrast films are used to record a longer range of tones as in a portrait. Therefore, the selection of the film should be governed by the contrast of the subject and the rendition desired.

The inherent contrast is the maximum contrast that an emulsion can produce with a minimum variation in exposure intensities. Usually, emulsions that have the slowest speed have the highest inherent contrast. The reason is that the slow film has smaller and more uniform silver halide crystals that respond more slowly to light of low intensities relative to light of high intensities. The fast films have larger crystals, due to the ripening during manufacture, and these films respond to lower intensities of light much more rapidly compared to the higher intensities than the slower films. This tends to flatten out or lower the contrast of faster films.

Contrast of the final negative can be influenced by many other factors. Development has a definite effect. In general, the greater the development, the greater the contrast. The lighting conditions of the original scene and the reflectance values of the subject determine the contrast of the scene you shoot. Therefore, it is very important to match the film and developer combination to the scene in terms of the final contrast you want to achieve.

Exercises (220):

1. Define contrast in terms of density.

2. In terms of density, state what is a normal contrast negative.

3. Identify what speed of film would have the higher inherent contrast.

4. State the effect that development has on contrast.

221. Complete statements about resolving power.

Resolving Power. Resolving power is the inherent property of an emulsion to resolve (reproduce) fine detail in the image. Resolving power is often expressed as the number of lines-per-millimeter (a millimeter is approximately 1/25 of an inch) that can be individually distinguished in the photographic image. Hence, the shorter the distance between the individual lines, the higher the resolving power. Or, the more lines per millimeter, the greater the resolving power as shown in figure 3-4.

Resolving power can be compared with several other characteristics of any film, as shown in figure 3-5. It is affected by so many factors that no one factor can be stated as the determining one except when particular conditions are stated. As with grain, to make high-quality enlargements from your negatives, you should select a film with high-resolving power.

The effect of exposure on resolution is significant. Resolution declines appreciably with overexposure or underexposure. Emulsions designed specifically to produce maximum resolving power may have an optimum density quite different from the optimum density for normal films. Therefore, even though a film is capable of resolving a large number of lines per millimeter, this is not necessarily an indication of what image quality the film will produce under actual operating conditions where subject contrast, processing, and exposure cannot always be at the optimum level for maximum resolution.

The resolution of films is constantly being improved. Usually, the very high resolution materials have extremely slow speed and very high contrast, which, as you recall, is characteristic of all the ultrafine grain emulsions. Fine grain is one of the prime factors in high resolution emulsions. Another important factor is correct processing. As you can understand, the choice of a particular film for a mission involves compromises between speed, grain, contrast, latitude, and resolving power.

Exercise (221):

1. Complete the following statements concerning resolving power.
   a. Resolving power is affected by __________ photographic factor(s).
   b. Over or under __________ will cause resolution to decline.
   c. Normally, film having very slow __________ and __________ contrast has the best resolving power.

222. State the color sensitivity of orthochromatic film and explain its limitations.

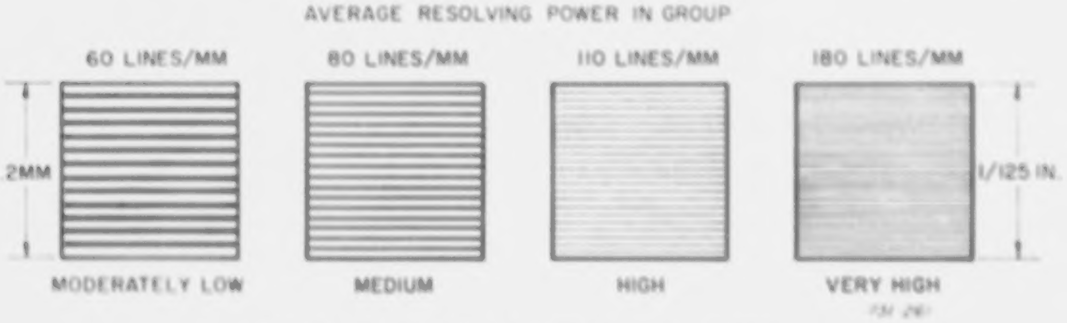

Figure 3-4. Examples of line resolution for typical emulsions.

FILM CHARACTERISTICS

Film Speed	Apparent Grain	Resolving Power	Latitude	Contrast
Fast	Coarse	Below 50 lines per millimeter	Wide	Low
Medium	Medium	50 to 75 lines per millimeter	Medium	Medium
Slow	Fine	Above 75 lines per millimeter	Short	High

231-262

Figure 3-5. Film characteristics.

Orthochromatic Film. The earliest film was sensitive only to blue light. Evenutally, dyes were added to blue-sensitive emulsions to make the silver halides sensitive to green light as well as to blue light. This film was named orthochromatic (true color) because it was felt that the ultimate in color sensitivity had been reached. The term was incorrectly applied, however, since the emulsion is not sensitive to red and, therefore, does not reproduce red in its correct shade of gray.

Ortho films, as they are often called, are made in several speeds and color sensitivity variations. They are excellent for many uses, provided that their incorrect rendition of the color red is taken into consideration when the scene is being photographed. Since they are not sensitive to red; red light does not (for practical purposes) make an image on the film. Therefore, after processing, red objects are relatively transparent on the negative and darker than normal on the print.

Exercise (222):

1. Specify the color sensitivity of orthochromatic film and explain why this limits its use.

223. Identify characteristics of panchromatic film.

Panchromatic Film. After dyes which could sensitize an emulsion to the green wavelengths of light (orthochromatic) were developed, researchers developed dyes that could sensitize silver halides to even longer wavelengths. This enabled the manufacturers to produce panchromatic emulsions that were sensitive to blue, green, and red light. The first panchromatic film came closer to approximating the sensitivity of the human eye than either the blue sensitive or orthochromatic emulsions.

Through further research, two additional and distinctly different types of panchromatic emulsions were made. Panchromatic emultions are classified as types A, B, and C. The original panchromatic emulsion, type A, has limited green sensitivity, and for this reason is not very popular today. Most of the current panchromatic emulsions are types B and C. Type C has considerably greater red sensitivity than type B. The sensitivity of type B film closely compares with the sensitivity of the eye.

Why is a panchromatic film desirable? Several factors are involved. For one thing, the red sensitivity of the emulsion tends to make the emulsion more sensitive to light and, therefore, promotes increased emulsion speeds. Red sensitivity is also important in trying to achieve orthochromatic rendition. (Orthochromatic rendition is rendering the scene in terms of gray tones in the same manner as the eye sees the scene.) Many panchromatic emulsions have the capability of recording fine detail and of producing good contrast. For these reasons, panchromatic film has become the standard black-and-white film for almost all missions.

Exercise (223):

1. From the following list, identify which characteristics apply to panchromatic film.
   a. Sensitive only to blue light.
   b. Poor tonal separation.
   c. Sensitive to red light.
   d. May be used to achieve orthochromatic rendition.
   e. Type A film is very sensitive to green light.
   f. Type C film is very sensitive to red light.

224. Identify the characteristics of different types of Polaroid films.

Polaroid. Photographers sometimes use Polaroid film to produce photographs when there is insufficient time for conventional processing methods, as in police work. As a training aid, Polaroid film provides a means for learning many photographic principles without the delay required for normal film processing and printing. Polaroid, which can produce a positive image within a matter of seconds, is also ideal for checking lighting or composition prior to using conventional film.

The Polaroid system is a specialized silver halide process. The outstanding feature of this system is that a finished print is available to the photographer in a matter of seconds after exposure, since the entire process can be carried out in the camera (or outside in some later models.) The positive image is developed by diffusion transfer that causes the latent image to be physically developed in a chemistry containing a silver halide solvent (hypo). In the Polaroid system, the exposed negative is developed in a high viscosity monobath solution. This solution is sandwiched between the exposed negative and the non-light sensitive positive transfer sheet. After a suitable developing time has elapsed, the two sheets are separated, and the positive image is contained in the transfer sheet.

Polaroid makes available a variety of film for different purposes including copy work and infrared recording. The following is a description of the more common types.

Types 42 and 52. Both of these films have medium speed, good tonal ranges, fine grain and medium contrast. Type 42 is a roll film producing a 3½" x 4½" (9 x 11 cm) image size with an ASA speed of 200. Type 52 comes in single exposure packets producing a 4" x 5" (10 x 13 cm) image size with an ASA of 400. Development time for both films is 15 seconds at 75° F. (23.9° C).

Types 105 and 55 P/N. Type 105 is a 3¼" x 4¼" (8.5 x 10.9 cm) eight-sheet pack film with an ASA of 75. It produces medium contrast fine grain prints and a negative that can be used for normal print production. 55 P/N has the same capability but in single 10 x 13 cm exposure packets with an ASA of 50.

Types 47, 57, and 107. Type 47 is a roll film with an image area of 3¼" x 4½" (8.5 x 11 cm). Type 57 is a 10 x 13 cm single exposure packet film. Type 107 comes in 8.5 x 10.9 cm film packs. All three of these panchromatic film types have an ASA of 3000, which makes them ideal for photography of high-speed events, many scientific applications, and general photography. As with conventional materials having high speed, resolution on the paper positive is low compared to slower films.

Exercise (224):

1. Match the Polaroid film types listed in column A with the appropriate description listed in column B.

Column A

1. Type 42.
2. Type 52.
3. Type 105.
4. Type 47.
5. Type 57.
6. Type 107.

Column B

a. ASA 3000 pack film.
b. Film has an ASA of 50 and produces both a positive and useful negative.
c. Roll film with an ASA of 200.
d. Roll film with an ASA of 3000.
e. Pack film that produces a negative and a positive.
f. Single exposure pack film with an ASA of 3000.
g. Pack film with an ASA of 400.
h. Single exposure packet film with an ASA of 400.

225. State characteristics of infrared film and procedures for its use.

Infrared Film. Infrared film is sensitive to the infrared (generally in the region of 700 to 900 nanometers in wavelength) portion of the electromagnetic spectrum that we consider to be invisible radiation. Even though infrared is not visible to the human eye, this film can "see" it; consequently, an exposure can be made.

In addition to the infrared sensitivity, the film is also sensitive to some ultraviolet and visible blue light. Because of the blue sensitivity, a filter must be used over the lens to absorb the blue light in order to obtain the proper infrared effect. Generally speaking, any deep red filter can be used; however, it is advisable to follow the manufacturer's recommendations. Figure 3-6 shows the sensitivity of infrared emulsions.

Infrared film has many applications in conventional, as well as aerial and scientific photography. In situations where sharp definition and contrast differentiation for distant objects are required, infrared film has definite advantages. The use of a panchromatic film in combination with a red filter provides good haze penetration where distant objects would otherwise be obscured. Although this haze penetration is good, the use of infrared film gives even greater haze penetration.

Since the infrared radiation has long wavelengths, it will not focus in the same plane as visible light. Because of this, it is necessary to refocus the lens. The lens-to-film distance must be slightly increased. Many newer cameras are equipped with an index mark to show the infrared focus point. If this point is not marked, it is advisable to use a small diaphragm opening to obtain as much depth of ~~focus~~ as possible. field

One of the features of an exposure taken outdoors on infrared film is the peculiar effect in the areas of natural vegetation. Normally, it would seem as though green subjects would produce very little exposure. This is true where the objects are colored green. Natural foliage that contains chlorophyl, however, causes a heavy exposure. The foliage, therefore, appears very white on a print. Infrared photography is used extensively by conservationists to identify diseased trees and plants. Compare the difference between figure 3-7, a print made from an infrared negative, and figure 3-8, that was made from a panchromatic negative.

Crime labs use infrared photography to detect forgeries and erasures, to decipher charred documents, to distinguish between various dyes, etc. In addition,

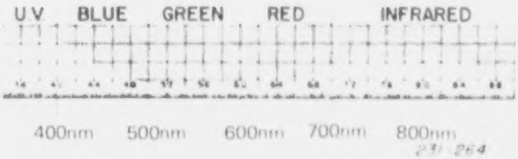

Figure 3-6. Sensitivity of infrared emulsion.

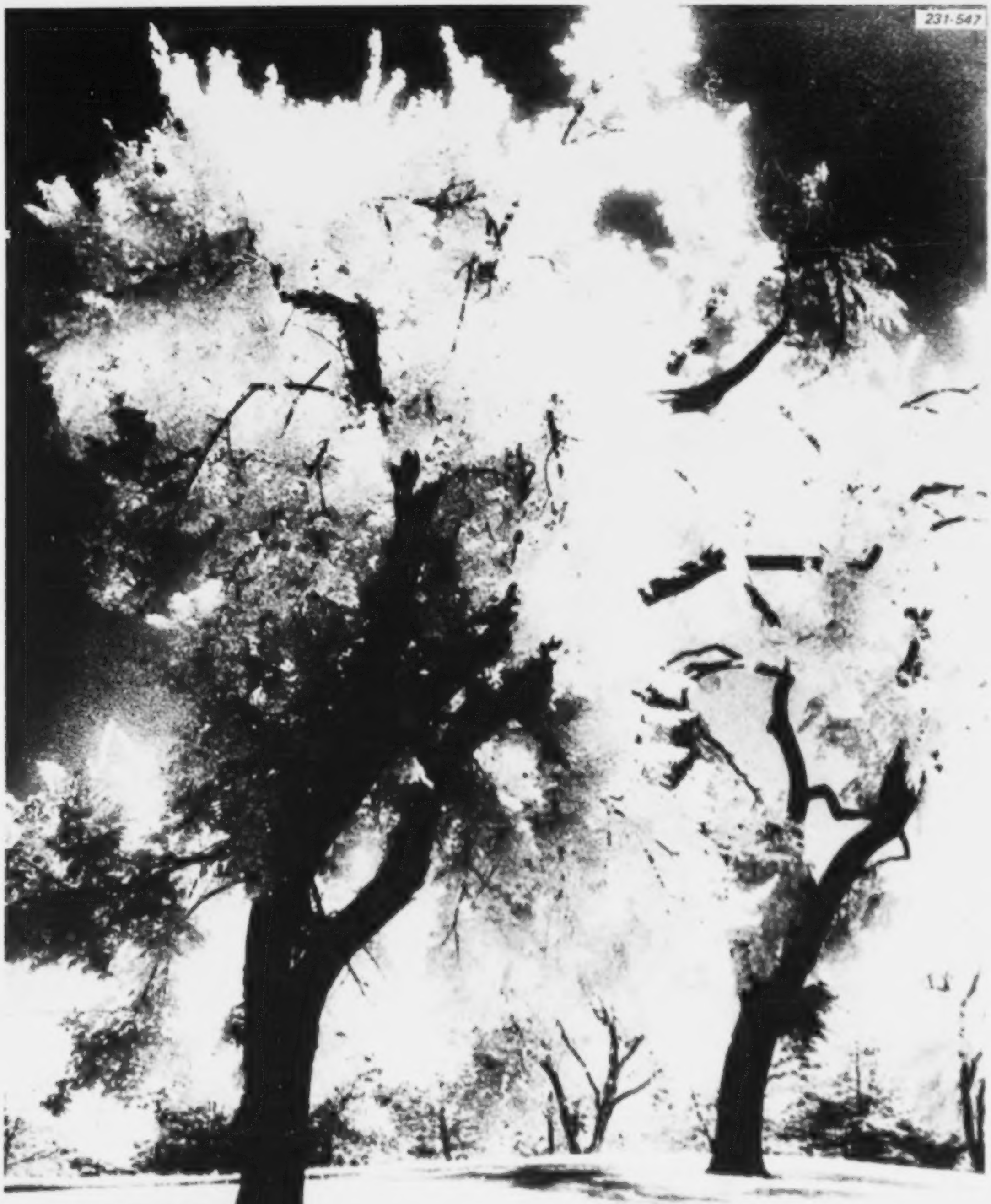

Figure 3-7. Print from infrared negative.

231 547

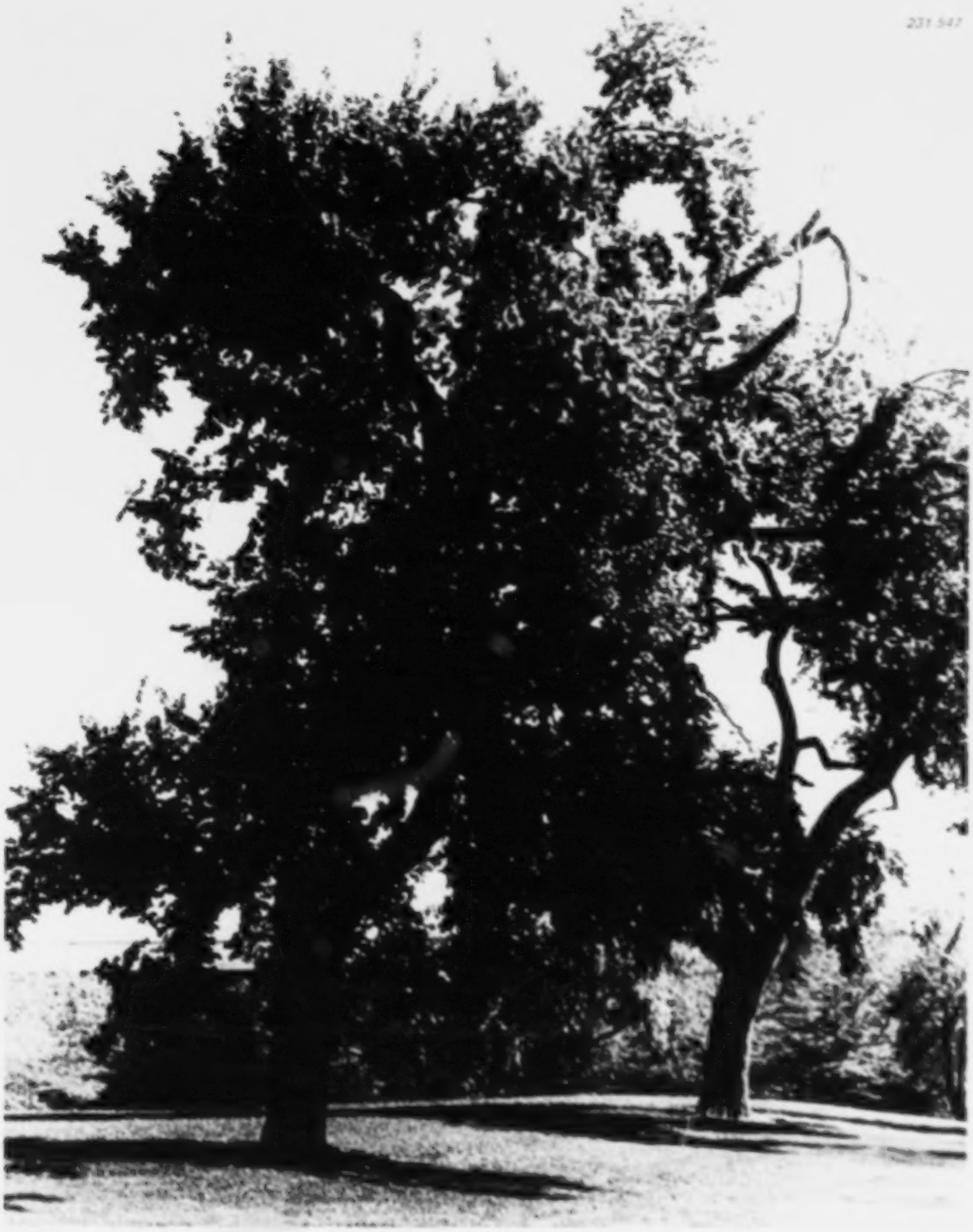

Figure 3-8. Print from panchromatic negative.

infrared film is useful in medical photography and other scientific and technical applications where infrared radiations are to be recorded.

Exercises (225):

1. When using infrared film, a ________ filter should be used.
2. Infrared film gives better ________ penetration than panchromatic film.
3. To insure proper focusing, the lens-to-film distance must be ________ when using infrared film.
4. Natural living foliage will produce a ________ exposure on infrared film.

CHAPTER 4

Photographic Optics

TWO photographers were talking one day about something they had both seen. It seems they had seen a beggar on the street corner. The first said, "Did you see that pathetic beggar back there?" The second photographer said, "Yes, he was in terrible shape, old, decrepit, poor, and filthy. Just pathetic. I felt so sorry for him." "I felt the same way," said the first guy, "and gave him a dollar. What did you give him?" "Oh," said the second photographer, "I gave him f/8 at 1/100."

We don't expect you to get quite this wrapped up in photography and optics, but you should know about the terms and principles that deal with optics.

4-1. Focal Length

"Focal length" is a term that is used to identify every lens. Therefore, it is a term you should be familiar with.

226. Define the term focal length.

The term focal length is defined as the distance from the optical center of the lens to the image produced by the lens at the focal plane, when the lens is focused on infinity (fig. 4-1). The optical center of a lens is a point, usually within a lens, at which the rays of light from different sources entering the lens are assumed to cross. For normal lenses, "infinity" is a condition that exists when light rays from distant objects enter the lens in a nearly parallel attitude. When the lens is focused at infinity, objects beyond the nearest point of infinity are always in focus. The focal length is expressed in inches or millimeters, and usually is engraved on the lens barrel.

Exercise (226):

1. Define "focal length" and "infinity."

4-2. Lens Speed and Aperture

In Chapter 2 we discussed f/stops and apertures. Here we show you how to compute an f/stop and define "lens speed."

227. Explain the f/stop formula and define slow and fast lenses.

The aperture is the opening inside the lens that permits light to pass through to the film when the shutter is open. The actual size of the aperture is controlled by a diaphragm. The size of the aperture for a given diaphragm setting is indicated by a particular f/stop number engraved on the diaphragm ring.

Lens Speed. You may have heard photographers talking about slow and fast lenses. You have probably guessed that this doesn't mean the lenses are on the track team. It means that a fast lens has a bigger maximum aperture than a slow lens as shown in figure 4-2.

If the maximum aperture of a 100mm lens is 50mm then the lens is called an f/2, 100mm lens. This is determined by using the formula $f = FL/D$. That is, $f(2) = FL(100) \div D(50)$. Another example of the lens speed formula may help. Suppose you have a 50mm lens with a maximum aperture of 6.25mm. What is the speed of your lens? Substituting in the formula, $f = FL/D$ you have, $f = 50 \div 6.25$, or you have determined that you have an f/8, 50mm lens.

What you have really discovered is that you have a very slow lens: the maximum aperture is f/8.

It is not extremely important for you to be able to compute the speed of a lens. But it is important that you know the difference between a fast and a slow lens and how to tell which is which. We have included the lens speed formula to help you understand how the speed is determined.

Now you know that if you have a choice between two 100mm lenses, one an f/2 and the other an f/4, the f/2 lens is faster. This is important if you know that there will be little light where you need to take your pictures. For example, suppose you need to shoot pictures of the base softball team playing a night game. Since you know that the f/2 lens is faster than the f/4 lens, you would take your f/2 lens.

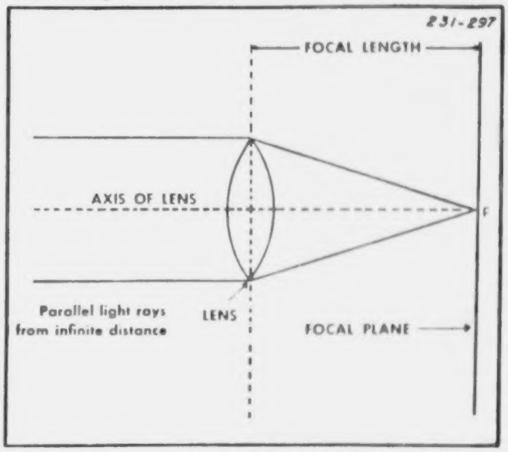

Figure 4-1. Focal length of lens.

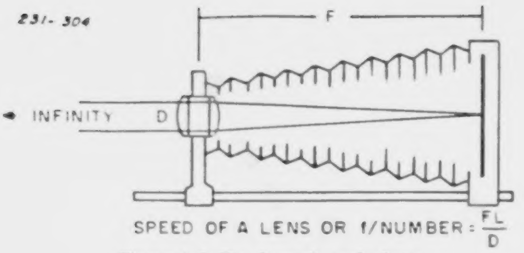
231-304
F
INFINITY
D
SPEED OF A LENS OR f/NUMBER = FL/D

Figure 4-2. The f/number of a lens.

All good lenses have an adjustable diaphragm to control the aperture of the lens. As the diaphragm is rotated to change the aperture, the appropriate f/stop is aligned with an indicator mark. The f/stops marked on the lens barrel are not always full stops. Due to lens design, they may start at a half-stop or a three-quarter stop. In such cases, the next f/stop is usually a full stop. To insure accuracy in figuring the exposure from one f/stop to the next, you should learn the full stops.

Exercises (227):

1. Define each factor in the formula $f = \frac{FL}{D}$.

2. What does the term "fast lens" mean?

3. What does the term "slow lens" mean?

4. Is an f/4, 100mm lens faster or slower than an f/2, 100mm lens?

4-3. Circle of Illumination

The circle of illumination as projected by a lens concerns a concept of optics that you need to understand. It has practical application that will be especially important to you when you work with view cameras. But right now we are interested mainly in its definition.

228. Define circle of illumination and usable circle of illumination.

Every positive lens projects a circular field of light. A positive lens converges rays of light toward the axis of the lens. A negative lens, which is unsuitable by itself for photographers, causes the rays to diverge. (NOTE: A positive lens is thicker at the center than at its edges. A negative lens is thicker at its edges than at the center.)

If you look at the circle of illumination projected by a positive lens (fig. 4-3) you will see that the light is brighter in the center than at the edges. The circle of illumination is the total light of the circle. Since the light falls off at the edges, this area of the circle of illumination of a lens is not used.

That brings us to the usable cirlce of illumination. The usable part of the entire circle of illumination is that part that is bright enough to produce usable images. This is a lot like the circle of light produced by a flashlight. When you use a flashlight, you try to keep what you are looking at in the center of the beam of

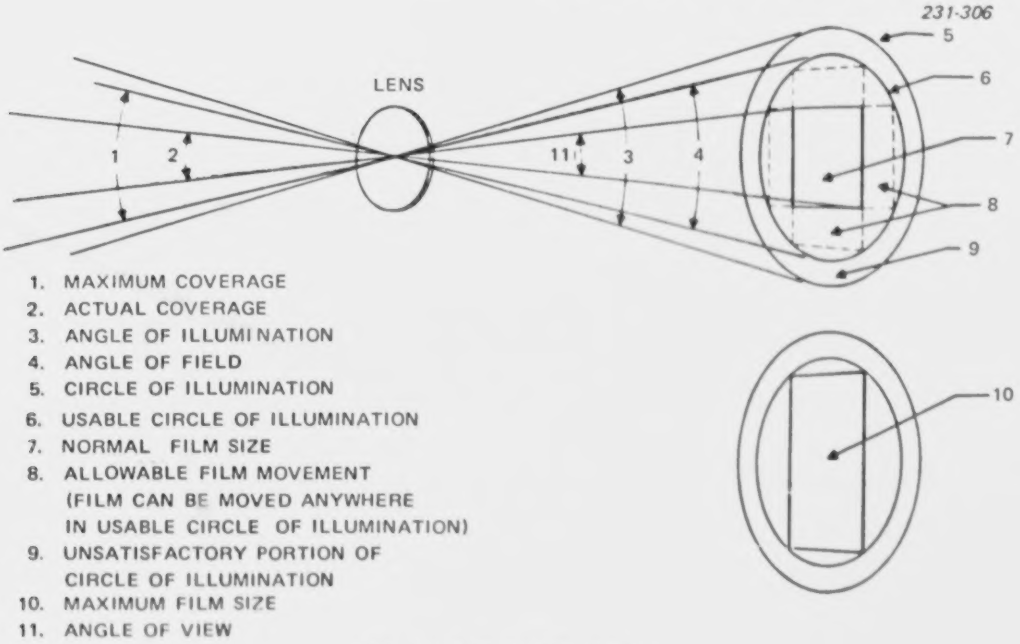
231-306
LENS
1
2
11
3
4
5
6
7
8
9
10
1. MAXIMUM COVERAGE
2. ACTUAL COVERAGE
3. ANGLE OF ILLUMINATION
4. ANGLE OF FIELD
5. CIRCLE OF ILLUMINATION
6. USABLE CIRCLE OF ILLUMINATION
7. NORMAL FILM SIZE
8. ALLOWABLE FILM MOVEMENT (FILM CAN BE MOVED ANYWHERE IN USABLE CIRCLE OF ILLUMINATION)
9. UNSATISFACTORY PORTION OF CIRCLE OF ILLUMINATION
10. MAXIMUM FILM SIZE
11. ANGLE OF VIEW

Figure 4-3. Circle of illumination.

light. As the object you are looking at gets closer to the edge of light, you can't see it as well.

The usable circle of illumination sets the limit on the film size you can safely use. It also limits the amount of correction you can use on a view camera. Figure 4-3 shows the circle of illumination and the usable circle of illumination.

Exercises (228):

1. Define the circle of illumination.

2. Define the usable circle of illumination.

4-4. Angle of Field and View

Angle of field and angle of view are terms that are dependent on two concepts you have just learned: focal length and circle of illumination.

229. Define angle of field and angle of view.

The focal length of a lens is a determining factor in the coverage of a lens. The maximum coverage of a lens is expressed in degrees as the angle of field. The angle of field of a lens is the widest angle at which light enters the lens and produces the usable portion of the circle of illumination. The maximum size of film that can be used with a lens depends on the angle of field, since any part of the film extending beyond the usable circle of illumination yields an indistinct image.

The size of the film ordinarily used with a lens is also limited by adjustments of the lens and film position. This necessitates the use of a smaller size film, because such adjustments sometimes move the film about in the circle of illumination or the position of the circle of illumination is changed by moving the lens. The angle of view of a lens is, therefore, the angle of light that is necessary to provide adequate coverage of the film that is being used. It is, therefore, never greater than the angle of field. Review figure 4-4.

Exercise (229):

1. Define angle of field and angle of view.

4-5. Resolution and Definition

Resolution and definitions are terms that are used to describe the "sharpness" or image quality produced by a given lens.

230. Define "resolution" and "definition" and briefly explain how they are determined.

Resolution. The term resolution or resolving power refers to the ability of a photographic lens or material to record fine detail. The normal method of measuring this quality is to photograph a suitable test pattern at a greatly reduced scale, and then examine the developed image under adequate magnification to calculate the smallest detail that is resolved. Resolving power should usually be considered with respect to a lens-film combination. The resolving power of a lens by itself indicates little because the final photographic product is a result of the combination of the lens and film.

The resolving power of a lens-film combination differs with variations in exposure, development, and subject contrast. Because of the effect of variables on the resolving power, the measurement is usually determined under strictly controlled conditions. Many different test patterns have been used by the photographic industry to determine resolving power, and the Air Force closely regulates its measurement in determining lens quality. At the present time the reatings of resolving power are given in terms of the lines-per-millimeter that can be distinguished.

The resolving power, as obtained for a given focus position at the various angles out to the corners of the sensitized material, is weighted by the percentage of the area of the zone, in which they occur, of the total area of the picture. This sytem of rating resolving power is known by the term "area weighted average resolution." The point that is most important photographically is not only the maximum resolving power, but whether

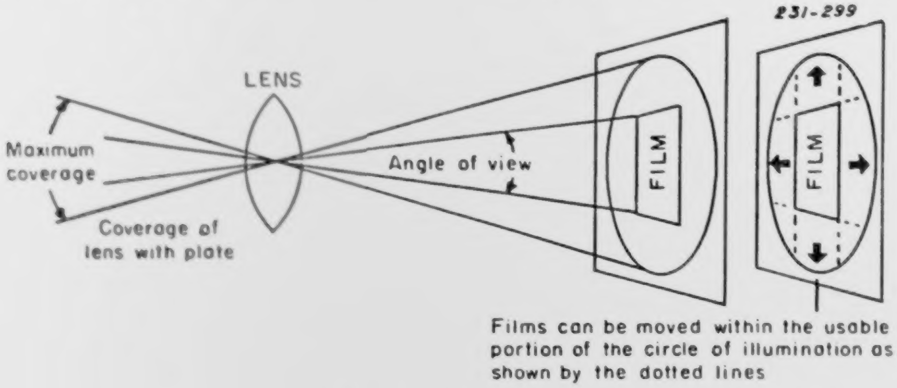
231-299
LENS
Maximum coverage
Angle of view
FILM
Coverage of lens with plate
FILM
Films can be moved within the usable portion of the circle of illumination as shown by the dotted lines

Figure 4-4. Angle of view.

the resolving power is ample over the entire format and over the range of densities or tones that are to be recorded when making the negative.

Definition. The term "photographic definition" refers to the quality aspect of a photograph that is associated with the clarity of detail. Since photographic definition is an impression made on the mind of an observer when he views a photograph, the concept of definition becomes subjective and depends on the viewer. Definition is a composite effect of at least four factors:

- Resolving power.
- Sharpness.
- Graininess.
- Tone reproduction.

Exercises (230):

1. Define resolving power and briefly describe how it is calculated.

2. Define definition and briefly describe how it is determined.

4-6. Coating

The coating on the surface of a lens affects its ability to resolve fine detail. Different manufacturers proudly exclaim the virtues of their lenses, and how well their coatings improve performance. You don't need to be able to rebut any of these claims, but you should be familiar with lens design characteristics.

231. Describe the purpose of a lens coating and the proper cleaning procedures necessary to preserve the coating.

For many years, it had been known that old lenses that had become tarnished with a bluish coating actually transmitted more light than new lenses. It is now common practice to coat lenses with a layer or layers of special coating that minimize internal reflections, thereby reducing optical flare (reflections off the glass surfaces of the lens) and improving transmission. By examining the front of a lens you will notice a slight color tinge (blue, yellow, etc.); this is caused by the lens coating used by the particular manufacturer.

Proper cleaning procedures should be observed to insure that this lens coating is not rubbed off. To clean a lens, first brush the surface with a fine brush to remove any foreign particles, then gently wipe the surface with a ~~soft cloth or~~ photographic lens tissue (not lens tissue for eyeglasses or wiping your nose), moistened with a recommended lens cleaner. ~~The lens can then be "polished" with a chamois~~. The key throughout the cleaning procedure is to avoid undue pressure or a hard rubbing action along the surface of the lens.

Exercises (231):

1. What is the purpose of coating a lens?

2. How should you clean a lens to prevent destruction of the lens coating?

4-7. Normal Focal Length Lens

Today, the photographer has a tremendous number of lenses to choose from to achieve the results he wants. Yet every camera comes with a "normal" lens.

232. Specify the rule for calculating the focal length of a normal lens.

The normal lens is considered to have a focal length that is about equal to the diagonal dimension of the film being used. The angle of coverage of a normal lens is approximately 45°. Normal lenses are usually the "fastest" lenses that are available and are therefore used for available light work. For the following standard film sizes, the following focal lengths are considered "normal."

Film Size	*Normal Focal Length*
35mm	50mm
120 (producing 2¼ x 2¼ image)	80mm
120 (producing 2¼ x 2¾ image)	90mm
4 x 5	150mm
8 x 10	300mm

Exercise (232):

1. What is the rule for calculating the focal length of a normal lens?

4-8. Wide Angle Lens

The wide angle lens has a shorter-than-normal focal length. That is, the focal length is less than the diagonal dimension of the film that is being used. Wide angle lenses have characteristics which you should be aware of.

233. Specify characteristics associated with the wide angle lens.

One of the main advantages of the wide angle lens is that it covers a wider subject area than that covered by a normal focal length lens at a given lens-to-subject distance. Typically, wide angle lenses cover from about 60° up to 180° for so-called "fisheye" lenses. This feature makes a wide angle lens the choice when you have a short lens-to-subject distance and you want to include as much of the subject as possible in the picture. Another advantage is that a wide angle lens has greater depth of field than the normal lens when both are used at the same lens-to-subject distance and aperture. This feature has made the wide angle lens a favorite of many photojournalists. They stop down their wide angle lens to a moderate aperture (for instance, f/11) to insure adequate depth of field at the average lens-to-subject distance they are using. Then they rely on depth of field ("zone focus") for sharpness rather than focusing each shot during fast moving events.

The advantages of the wide angle also create some problems to be considered. The wide angle coverage often produces a challenge to compose all of the picture elements effectively. Many beginning photographers choose a wide angle lens because they can get more in their pictures. This often leads to compositions that are confusing because of an absence of a strong point of interest. This is particularly true since the relative subject size is smaller as compared to a longer focal length lens at the same shooting distance. In addition, the wide angle creates distortions resulting in elongation or curving of lines that may not be pleasing. Also, because of the complex nature of many wide angle designs, the lenses tend to be sharper in the center than at the edges. This necessitates stopping down the lens a couple of f/stops to insure better sharpness.

Taking all these things into consideration, the wide angle lens can be very effective when shooting in cramped quarters, when covering fast breaking news events, when photographing scenics, and for obtaining an overall shot of the scene (establishing shot).

Exercise (233):

1. Complete the following statements on the characteristics of wide angle lenses.
   a. Wide angle lenses have __________ than normal focal lengths.
   b. At a given lens-to-subject distance, the subject will appear __________ when using a wide angle lens than one with a longer focal length.
   c. At a given aperture and lens-to-subject distance, you will obtain more _____ _____ _____ when using a wide angle lens than when using a normal lens.
   d. Generally speaking, wide angle lenses are sharper in the _____ than at the _____.

4-9. Long-Focal-Length Lenses

Now that you have become familiar with normal and wide angle lenses, you will learn about long-focal-length lenses.

234. Give selected characteristics of long-focal-length lenses.

Long focal length refers to any lens that has a focal length greater than normal (i.e., greater than the diagonal dimension of the film) and relies on this fact to produce a large image size. Such lenses do not have to be of special design but are often the result of taking a lens designed for a larger camera and using it on camera having smaller film size. For example, you may be using a 4 x 5 press camera that is normally equipped with a 150mm lens. If this lens were replaced by a 300mm lens used on an 8 x 10 camera, the 300mm lens would be a long-focal-length lens on the 4 x 5 camera. (It is pointed out in the next section that a telephoto lens achieves the long-focal-length effect through special design.)

The advantage of a long-focal-length lens is like a telescope, that it has a narrower angle of coverage (about 35° or narrower), and produces a larger image size than a normal lens at the same lens-to-subject distance. This makes the lens ideal for portraits, sports, photography, and nature photography. Such a long-reaching lens makes it easier for the beginner to isolate his subject to achieve better composition.

There are disadvantages to using a long-focal-length lens. One problem is that unless the lens was designed for the camera that is being used, it may be difficult to attach properly. The size and weight of the lens may change the balance of the camera and require proper tripod support. Rigidity is further required because camera-movement is magnified by this type of lens. Long-focal-length lenses are slow and require using high speed film or supplementary lights. Finally, the depth of field of a long-focal-length lens is inherently less at a given aperture than a normal or wide angle lens at the same lens-to-subject distances. This problem is compounded by the fact that fast shutter speeds needed to prevent camera shake exclude small apertures.

NOTE: Long-focal-length lenses are primarily applicable to view and press cameras that use bellows for focusing and lens boards to interchange lenses. These features permit the interchange of lenses designed for different film formats which does not apply to small cameras.

Exercises (234):

1. How would you define a long-focal-length lens?

2. Why is it easier to achieve better composition with the long-focal-length lens as compared with shorter lenses?

3. Why do you need to use high shutter speeds when photographing with a long-focal-length lens?

4-10. Telephoto Lenses

Though the terms telephoto and long focal length have been used interchangeably, the term telephoto is properly applied only to lenses that have a particular optical design. Telephoto lenses have become the standard for long-reaching lenses designed for the small roll film cameras which you will be using.

235. Identify correct and incorrect statements about characteristics that apply to telephoto lenses.

A telephoto lens gives a larger image than does the conventional lens at the same lens-to-subject distance. This is achieved by using a combination of increased focal length and a negative rear element spaced some distance away from the positive-image forming element. This type of design "pushes" the optical (not physical) center of the lens forward so that it is in front of the positive image forming element. This enables the lens to have an effective focal length that is longer than its actual physical length (see fig. 4-5). Due to the shorter length, the telephoto lenses are lighter and less bulkier than their traditional long-focal-length counterparts which depended on focal length alone. The telephoto type is therefore ideal for small cameras.

The advantages and disadvantages of using a telephoto lens are similar to those of the long-focal-length lenses. A telephoto produces a greater image size and a narrower angle of field than normal lenses. Telephoto lenses are therefore invaluable for sports, nature studies, and individual portraits. Their limited depth of field and narrower angle aid in composition by emphasizing the main subject. Their long reach permits the photographer to work farther away and this is important with many live subjects. The main disadvantages are that telephoto lens are usually slow thus they emphasize any kind of camera shake. (A good rule of thumb is that you should use a shutter speed approximately equal to the length of the lens. If the lens is 100mm, then use a shutter speed of 1/125; if the lens is 500mm, then use a shutter speed of 1/500.)

Exercise (235):

1. Identify each of the following statements concerning telephoto lenses as true or false.
   a. The telephoto lens achieves its photographic affect by using a special optical design.
   b. Telephoto lenses are more convenient to use than long-focal-length lenses.
   c. It is more difficult to emphasize the subject when using a telephoto lens than when using a wide-angle lens.
   d. When using a 250mm lens, your shutter speed should be about 1/250.
   e. Telephoto lenses are more suitable for available light work than normal lenses.

4-11. Zoom Lenses

Zoom lenses are generally thought of as special purpose lenses. They do have some advantages, disadvantages, and certain applications.

236. List one advantage and one disadvantage of zoom lenses.

A zoom lens gets its name because of its ability to zoom in or out from the subject. That is, from one camera position you can use a zoom lens to get the effects of your normal and telephoto lenses.

If your subject is close to you, you can use the normal focal length position. Then if your subject moves away from you, you can adjust the focal length and keep the image size pretty much the same. The obvious advantage is that you can change focal lengths, without changing lenses.

Nearly everything with an advantage has some disadvantages. Zoom lenses are no different. The main disadvantage with a zoom lens is that it does not produce sharp images. This is all right if image sharpness is not a critical factor.

Zoom lenses also let you be creative as shown in figure 4-6.

Exercises (236):

1. What is an advantage of a zoom lens?

2. List one disadvantage of a zoom lens.

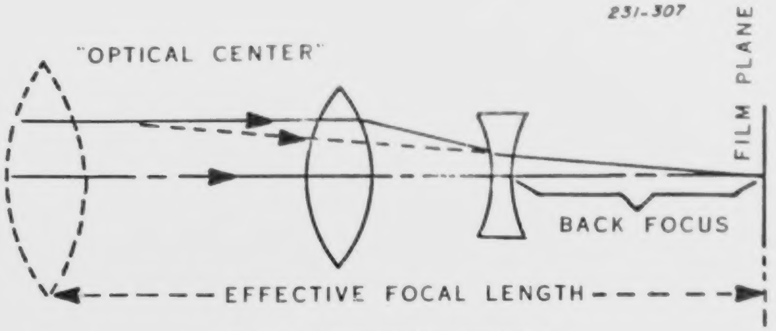

Figure 4-5. Basic telephoto lens design

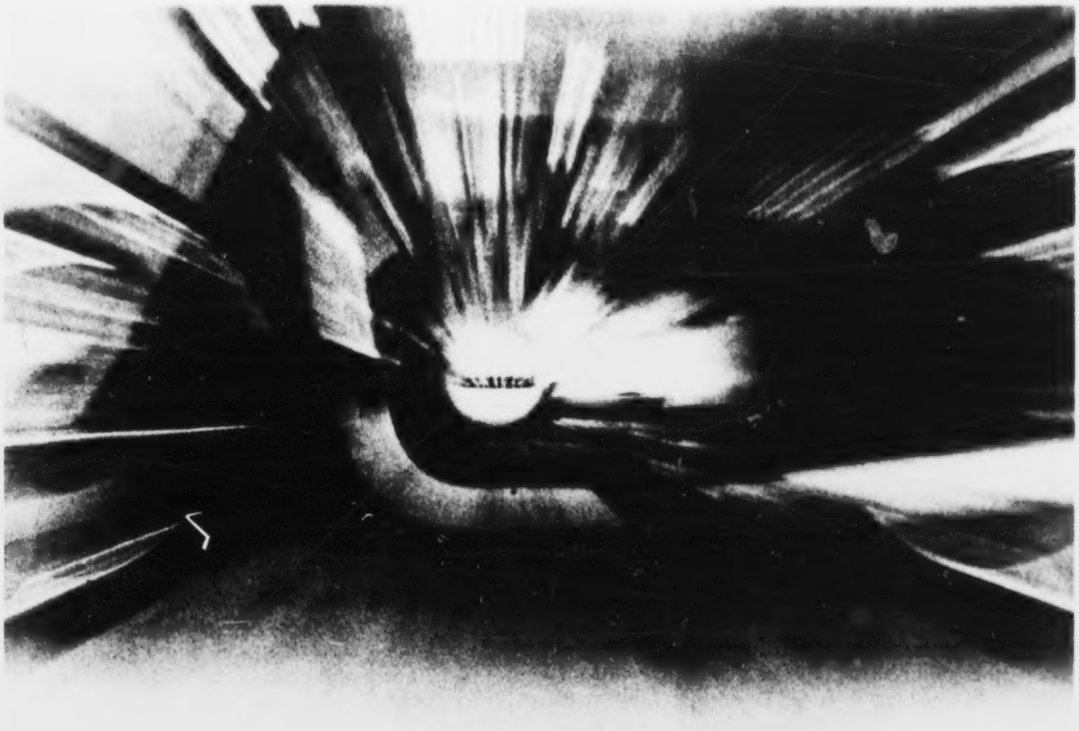

Figure 4-6. Zoom lens effect.

4-12. Image Size Control

As a photographer, you need to carefully consider the relative size of your subject and other picture elements. Not only is this an important aspect of composition, but it is also a vital element throughout the reproduction cycle.

237. Describe the two photographic controls that are used to determine image size.

Given a particular film format, two factors that control image size are focal length of the lens and the lens-to-subject distance. The longer the focal length, the larger the image on the film for a given lens-to-subject distance. Therefore, by using a camera with an interchangeable lens capability and by having a selection of lenses, the photographer can control image size for any given shooting distance. Conversely, for any given focal length of lens, the closer you are to the subject, the bigger the image will be. (Unfortunately, many lenses do not focus closer than a couple of feet from the subject.) You should, therefore, always balance between shooting distance and focal length to achieve the results you want.

Exercise (237):

1. Identify and describe the two controls that can be used to determine image size.

4-13. Perspective

You can see objects in three dimensions, but a lens forms images in only two dimensions (height and width). The missing dimension, depth, is suggested by the relative position and size of the objects in the image. Foreground objects are large, and background objects appear smaller. The relation of these objects, called perspective, is of considerable importance because it controls the naturalness of the picture.

238. Define perspective.

Again, let us define perspective. It is the *impression* of depth when a 3-dimensional scene is represented in a 2-dimensional photograph. We are trying to make a distinction between perspective and perception. The perspective is there when you position the camera. That is, things close to the camera will appear to be close in the finished picture. The only way to make them appear to be far away is to move the camera.

Nothing will change the relative perspective. However, focal length of the lens can change your perception. For instance, recall the telephoto shot of a baseball pitcher and the catcher you see on the Saturday ballgame on TV. You can tell that the catcher is farther away than the pitcher. But because of the long focal length your perception is changed. It now appears as though the pitcher and catcher can shake hands.

The change of lenses will change image size but will not change the relative position of the pitcher and catcher. We can safely say then that perspective is controlled completely by the camera position.

Exercises (238):

1. Define perspective.

2. Will focal length change perspective? Explain.

4-14. Depth of Field and Focus

Depth of field and depth of focus are interrelated optical factors that affect the sharpness of your photographic images. Both of these concepts are important and, in particular, depth of field should be considered with every photograph you take.

239. Define depth of field and hyperfocal distance.

Depth of Field. The zone extending in front of and behind the point of sharpest focus throughout which focus is acceptable is the depth of field. Figure 4-7 graphically shows this zone of acceptable focus.

The application of depth of field is very important because practically all photographic subjects, except flat copy subjects, are in more than one plane and therefore have depth. It is very important for you to be able to control and calculate what parts of the subject will appear sharp to the viewer.

The following factors within the control of the photographer all influence depth of field.

- Focal length. Other factors remaining constant, the shorter the focal length of the lens, the greater the depth of field.
- Lens to subject distance. Other factors remaining constant, the farther the object is from the lens, the greater the depth of field.
- The aperture (diaphragm). Other factors remaining constant, the smaller the f/stop setting, the **greater the depth of field (see fig. 4-8).** (It should be emphasized, however, that stopping down the diaphragm does not improve the sharpness of the point focused upon, but rather makes points to the front and rear sharper. In fact, due to the optical problem of diffraction, stopping down to the smallest aperture setting may actually cause an overall loss of image quality.)

To summarize by example, when you use a wide angle lens stopped down to f/16 to shoot a scenic, you will have great depth of field; but when you use a telephoto lens opened to f/2.8 to shoot a head and shoulder portrait, you will have very little depth of field. It is therefore important to consider these factors every time you shoot. Depth of field can be a creative tool. A limited depth of field can make the subject stand out, while great depth of field can produce wide ranging detail. The choice is yours, but you should know what you are doing and why you are doing it.

The actual depth of field for any given shooting situation can be measured. Lens manufacturers produce depth-of-field tables that tell you the exact area covered by a given lens, lens to subject distance, and f/stop combination. Also, depth of field scales are engraved on many lenses. Figure 4-9 illustrates a lens that provides a depth of field scale. To calculate the depth of field for a given focusing distance (10 feet, 3 meters in the illustration) and a given aperture (F/8), refer to the numbers on either side of the focusing index that relate to the aperture being used and then read the distance opposite the f/stop number. For example, in the illustration, reading up from f/8 on each side gives a distance (using the foot scale) of from 8 to 15 feet. Also, many single lens reflex cameras have a depth of field preview button that when depressed shows the image at the taking aperture. This gives you a rough visual idea of what areas will appear sharp.

2/5ths Rule. The 2/5ths rule is another application of depth of field. The 2/5ths rule is a generalization that states: When a plane is focused upon, for each 2 feet in front of that plane that is in acceptable focus, 3

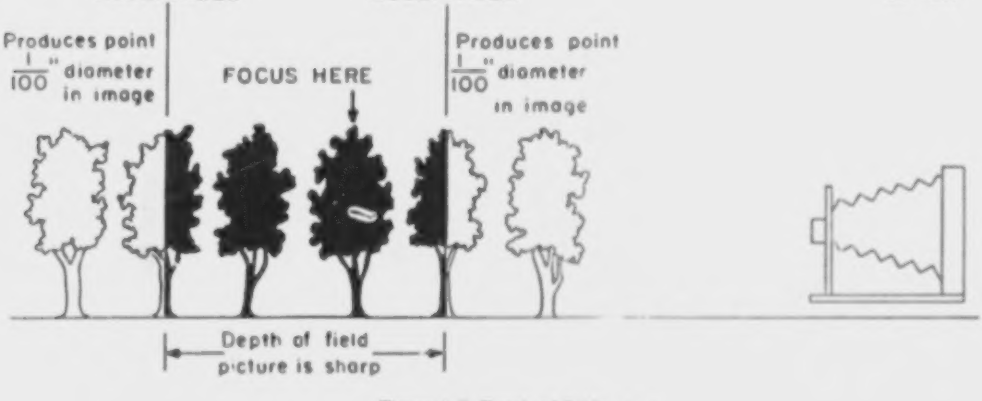
ACCEPTABLE
ACCEPTABLE
231-311
Produces point $\frac{1}{100}$" diameter in image
FOCUS HERE
Produces point $\frac{1}{100}$" diameter in image
Depth of field picture is sharp

Figure 4-7. Depth of field

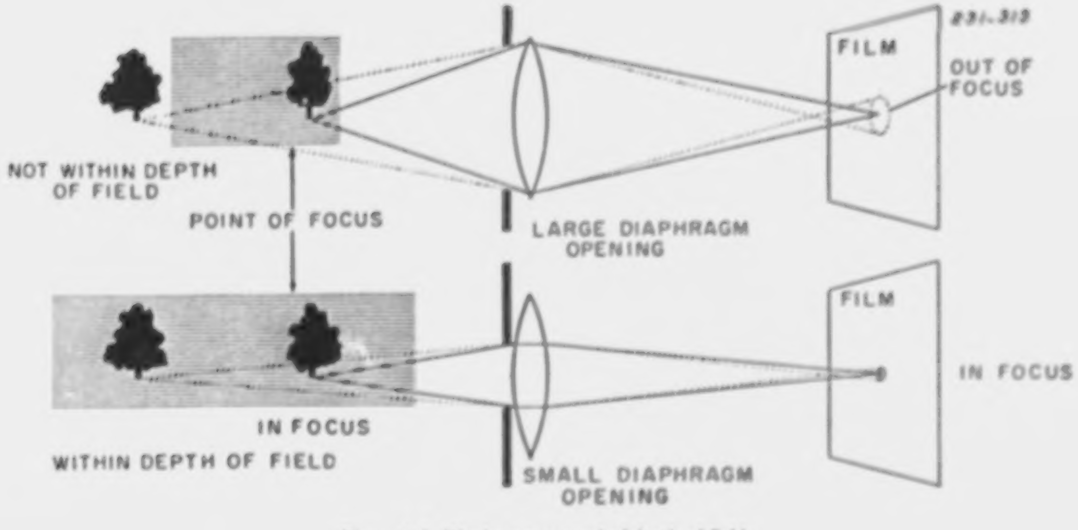

Figure 4-8. Diaphragm control of depth of field.

feet behind that plane will be in acceptable focus. The first step in applying this rule is to determine the nearest and the farthest points you wish to include in your depth of field. When this can be calculated, divide this total distance into fifths. Then, focus upon a plane, or subject point 2/5ths of the distance beyond the nearest acceptable plane. After this, stop down the diaphragm until the nearest and farthest planes come into acceptably sharp focus. (This procedure works with cameras that have ground glass focusing. If you are using a rangefinder camera, you will have to rely on your depth of field scale.) Study figure 4-10 to see how this works.

The 2/5ths rule is exact only for the average scene (near the hyperfocal distance), but for all practical purposes it can be applied for any distance where the subject is greater than 6 feet from the lens. As the point focused upon comes closer to the lens, the 2-to-5 ratio gradually approaches equality until at 2 focal lengths between the lens and the subject, the ratio becomes 1:1.

Hyperfocal Distance. The term "hyperfocal distance" refers to the distance from the lens to the nearest plane in acceptable focus when the lens is focused on an object at infinity. The hyperfocal distance varies with aperture and focal length. Everything from the hyperfocal point to infinity is in acceptable focus; everything from the hyperfocal point to the lens is beyond the limits of acceptability. The easiest way to set a lens for the hyperfocal distance is to set the infinity mark of the focusing scale opposite the selected f/stop engraved on the far side of the depth of field scale. This insures that the depth of field will cover from the nearest possible point to infinity. This is the way to maximize depth of field for a given aperture/focal length combination. Remember that each f/stop has a different hyperfocal distance.

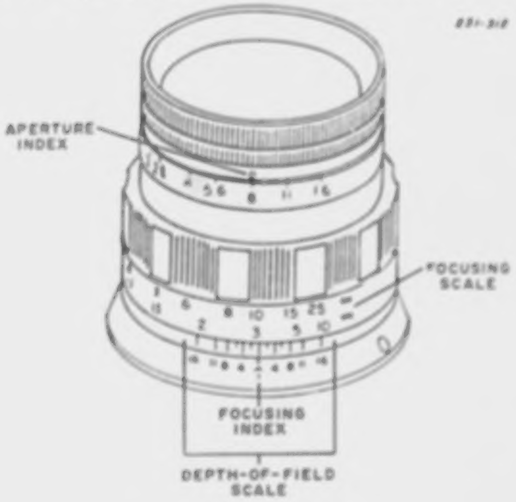

Figure 4-9. Depth of field scale.

Exercises (239):

1. Define depth of field.

2. List and explain the three factors the photographer can use to control depth of field.

3. If you need to photograph an object that is 5 feet long, and you want the entire object in focus, how far into the object should you focus?

4. Define hyperfocal distance.

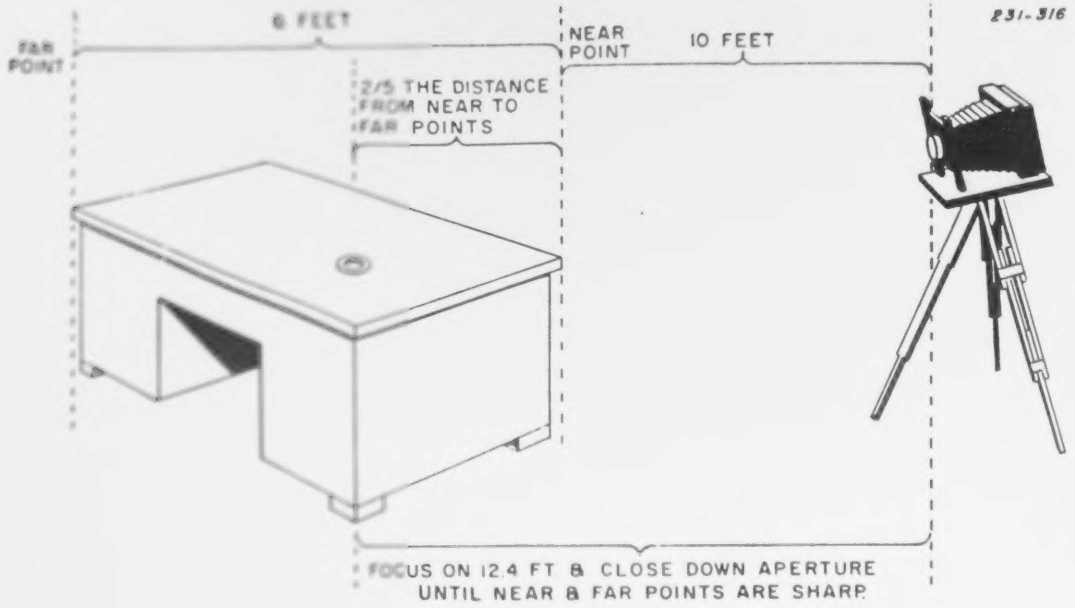
231-316
6 FEET
FAR POINT
NEAR POINT
10 FEET
2/5 THE DISTANCE FROM NEAR TO FAR POINTS
FOCUS ON 12.4 FT & CLOSE DOWN APERTURE UNTIL NEAR & FAR POINTS ARE SHARP

Figure 4-10. The 2/5th rule.

240. Define depth of focus.

Depth of Focus. This is the *zone* or area within which the film can be moved before the image on the film becomes unsharp. Depth of focus varies with numerous factors. Just as depth of field, depth of focus is changed by focal length, lens to subject distance, and aperture.

Like depth of field, depth of focus increases as the aperture is stopped down. Unlike depth of field, depth of focus increases as focal length increases, and increases as subject distance decreases. Depth of focus is a concern of the manufacturer, but it is a good idea to keep in mind when using a view camera where the film plane is moved about and in doing critical closeup work where precise focusing is essential. Figure 4-11 shows the area of sharp focus or depth of focus.

Exercise (240):

1. Define depth of focus.

4-15. Critical Aperture

To get the best results possible from your lenses, you should know the critical aperture for each one.

241. Define critical aperture.

Physical limitations in the design of lenses make it impossible to manufacture a lens of uniform quality and performance from its center to its edges when used at all focusing distances and all possible apertures. Therefore, to obtain the best quality with most lenses, many manufacturers recommend eliminating the use of the lens edge by decreasing the diaphragm opening about two stops from the largest aperture. This or any other aperture that transmits the sharpest image is considered the critical aperture.

You should test each lens in your camera system and determine the critical aperture for each one. The critical aperture varies from type to type, brand to brand, and even within lenses with the same brand and description. By knowing how each of your lenses perform, you will be able to bring home the sharpest results.

Exercise (241):

1. Define critical aperture.

4-16. Flare

There are two general types of flare: mechanical and optical. Because they can reduce the sharpness of your images, you should know how each type can be eliminated.

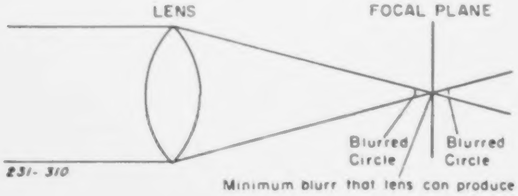
LENS
FOCAL PLANE
Blurred Circle
Blurred Circle
231-310
Minimum blurr that lens can produce

Figure 4-11. Depth of focus.

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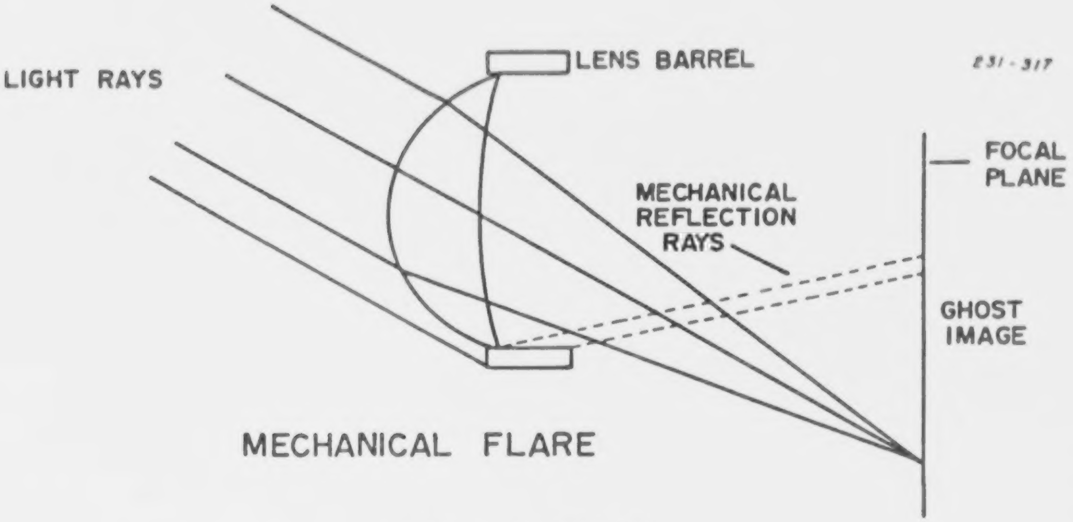
LIGHT RAYS
LENS BARREL
231-317
FOCAL PLANE
MECHANICAL REFLECTION RAYS
GHOST IMAGE
MECHANICAL FLARE

Figure 4-12. Mechanical flare.

242. Briefly explain the two types of flare and tell how they can be reduced or eliminated.

Mechanical Flare. Mechanical flare is caused by reflections that occur because of reflective surfaces on the inner side of the lens barrel, the camera, or anywhere else near the lens. Normally, mechanical flare is not an inherent characteristic of the lens, but it is the result of a damaged or burnished surface. Instead of being absorbed, light coming from the subject strikes such surfaces and is reflected onto the film. This flare can be eliminated by coating damaged surfaces with a nonreflective coating (fig. 4-12).

Optical Flare. Optical flare is (fig. 4-13) caused by internal reflections from the glass-to-air surfaces of the lens. Optical flare is present to some extent in any lens having more than one element. Generally speaking, because of the greater number of glass-to-air surfaces, the more complex the lens, the greater the amount of optical flare. The problem of optical flare has been greatly reduced by coating lenses. The photographer can also help himself by always using a lens shade and not pointing the camera directly into the sun (fig. 4-14).

Exercises (242):

1. Briefly explain how mechanical flare is caused and how it can be corrected.

2. Briefly explain how optical flare is caused and how it can be corrected.

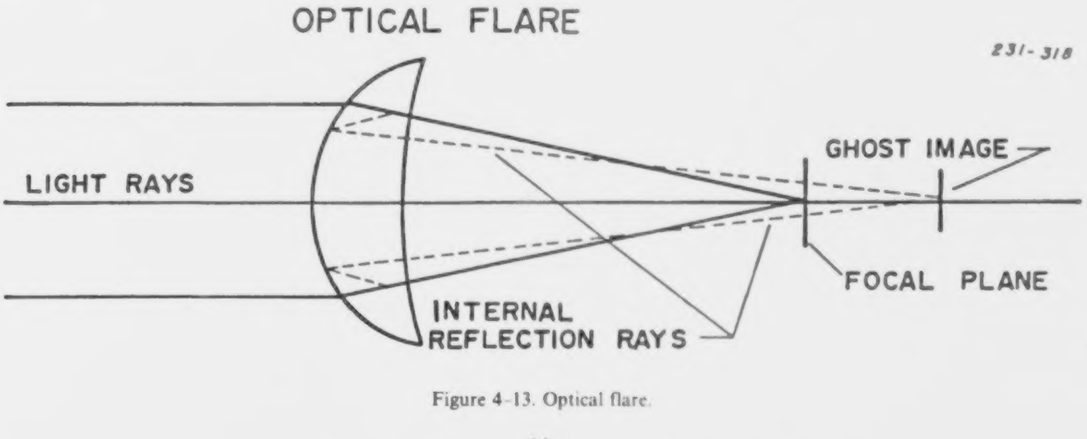
OPTICAL FLARE
231-318
GHOST IMAGE
LIGHT RAYS
FOCAL PLANE
INTERNAL REFLECTION RAYS

Figure 4-13. Optical flare.

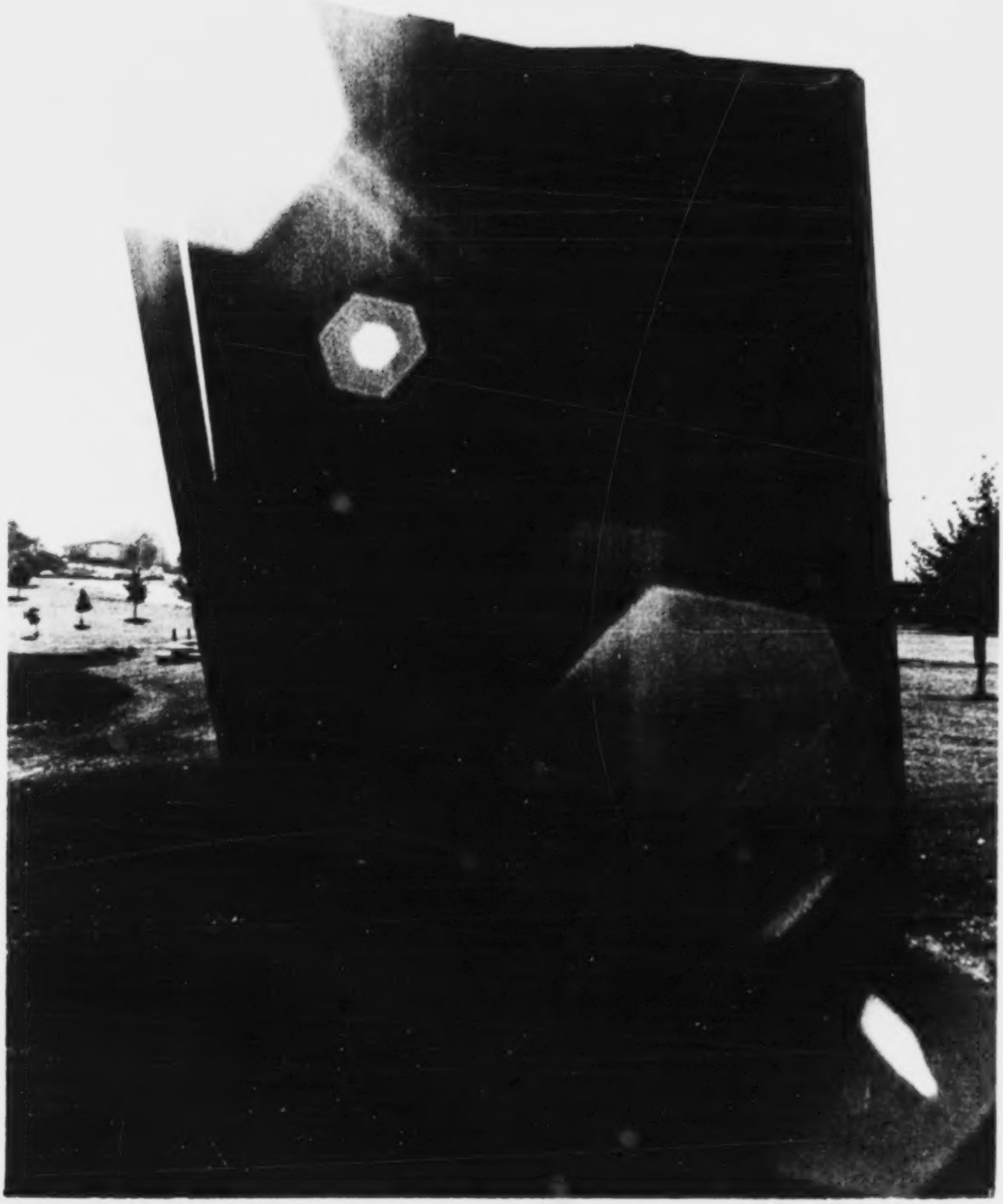

Figure 4-14. Example of optical flare.

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CHAPTER 5

Photographic Filters

AN AIRMAN WHO was in need of a new suit went into the local clothing store. The salesman showed the airman several suits. Finally the airman said, "This is a fine suit, but don't you have one like it in blue"?

"Blue!" said the salesman, "Harry, put a blue filter over the light; the man wants a blue suit."

In photography, filters are used to control the light striking the film. By effectively using filters, you can change the relative contrast between colors. You can isolate, subdue, enhance, or eliminate a color by using the proper filter. Filters, when thoughtfully chosen, can help you achieve better quality in your photographic work (or even help you buy a blue suit.)

5-1. Construction

Filters are primarily of two kinds—dyed gelatin or colored glass. Let us discuss the advantages and care for both.

243. Specify specified characteristics of gelatin and glass filters.

Gelatin Filters. The simplest filter is a sheet of dyed gelatin that can be cut into pieces of the appropriate size and held in front of the lens by a suitable holder. Gelatin filters are inexpensive and come in the widest variety of colors. Thus, they are very popular for experimentation, color photography, and for use with odd-size lenses. The main disadvantage of a gelatin filter is that it is delicate. Scratches, discolored spots, and fingerprints will render the filter useless.

Glass Filters. Glass filters are made out of dyed glass or by using a sheet of dyed gelatin between two sheets of glass. They come in a variety of sizes (designated in millimeters or series) and types. A glass filter may be either screwed into the front of the lens or held by a retaining ring (used for series filters). Glass filters are more expensive and durable than gelatin filters but do not come in quite the variety of colors and density ranges. Each glass filter should be treated just like a lens. Any lint or dust should be removed with a brush. Lens tissue moistened in lens cleaner should be used to remove fingerprints.

NOTE: All filters, regardless of the method of manufacture, fade with use. It is, therefore, a good idea to replace your filters at regular intervals.

Exercises (243):

1. What are two advantages of using a gelatin filter?

2. What is the main advantage of a glass filter over a gelatin filter?

3. In time, what happens to any filter?

5-2. Effects and Limitations

The photographic filter is an optical device for controlling the transmission of light to the film. To understand the use of filters you apply what you know about the sensitivity of film and the color quality of light. Using filters is easy and will greatly enhance your photographic work. In this section you will learn what a filter does to light.

244. Identify the color, absorption, and transmission of different colored filters and for given conditions, identify likely problems in filter application.

White Light. White light or visible light is composed of blue, green, and red wavelengths of light. These three colors are called the additive primary colors because none of these can be created by any combination of the other two. In addition, all three of these colors of light must be present to combine and create white light. If blue and green light are combined in equal quantities, they form cyan. A combination of blue and red light produces magenta, and green and red light combine to produce yellow. Cyan, magenta, and yellow are called subtractive primary colors.

The color star in figure 5-1 shows the additive and subtractive primary colors in a logical arrangement. Notice that each color in the star has a color directly opposite it. Colors on opposite sides of the color star are called complementary colors. When each of the complementary colors of light are mixed in the correct proportion, they also produce white light. Magenta and green are complementary, and they can combine to form white light. Magenta is actually red and blue. When green is added, all three additive primary colors are present and white light is formed. In the same way, red and cyan are complementary, and blue and yellow are complementary. To repeat, red, green, and blue light combined in the correct proportions make white light.

Filter Application. By using a filter over a camera lens, we can employ what is known as sutractive color filtration. As this is explained, you should carefully study figure 5-2.

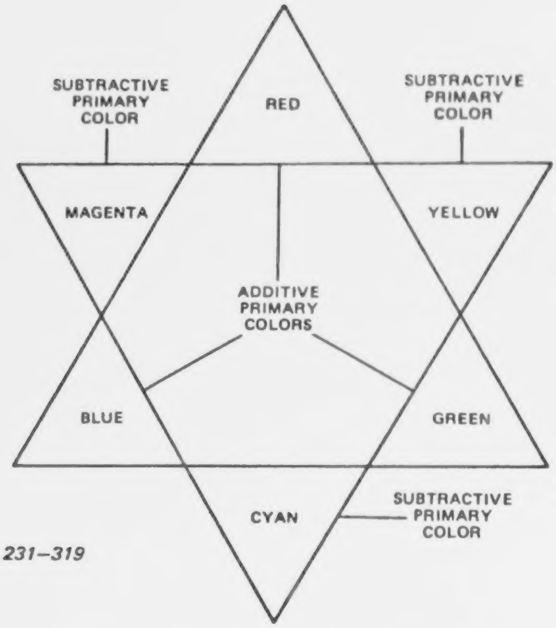
SUBTRACTIVE PRIMARY COLOR
RED
SUBTRACTIVE PRIMARY COLOR
MAGENTA
YELLOW
ADDITIVE PRIMARY COLORS
BLUE
GREEN
CYAN
SUBTRACTIVE PRIMARY COLOR
231–319

Figure 5-1. The color star.

First, let us consider the effect produced when the additive primary filters are placed in front of a white light source. Notice that each additive filter passes only its own color and absorbs the other two additive primary colors. It stands to reason then that when any two or all three of the additive primary colored filters overlap, no light is allowed to pass.

Now consider the effect produced by subtractive primary filters. Each subtractive primary filter passes its own color - the two colors that combine to create it. As an example, a yellow filter passes yellow light, and since they combine to form yellow, also passes red and green. The yellow filter will not pass its complementary color blue, and for this reason a yellow filter is often referred to as a minus blue filter. Notice that total absorption of light by subtractive primary filters occurs only when all three filters overlap.

It is helpful to think of filters in terms of the colors they subtract from white. Red is a minus blue and green while cyan is a minus red, etc. (see fig. 5-3). In this way the result of the finished print from a black and white negative that was exposed by filtered light can be rapidly calculated. Any color that is passed will print light because it creates a greater percentage of negative density when compared with the color(s) of light that are absorbed. For example, suppose you are taking a photograph of a red barn. You are using panchromatic film and a green filter. The red colored light being reflected off the barn will be absorbed while the green light reflected off the background will pass through. The result on the negative will be a thin barn and dense surrounding area. A print, therefore, will be a dark barn and light background.

NOTE: The exact transmission and absorption pattern depends on a number of factors. The density of the filter (the darker the filter the more absorption), the exposure, the color of the lighting, and the type of film being used are all ingredients. You therefore need to experiment to insure the results you want.

Effect of Filters on the Plane of Focus. Any filter, whether located in front of or behind the lens (occasionally gelatin filters are taped to the back of the lens), will affect the plane of focus to some degree. (The thicker the filter the more the effect.) Whenever possible, it is advisable to focus the camera with the filter in place (an advantage of ground glass or ~~reflect~~ reflex focusing cameras). This is especially true when high-precision closeup work is being done.

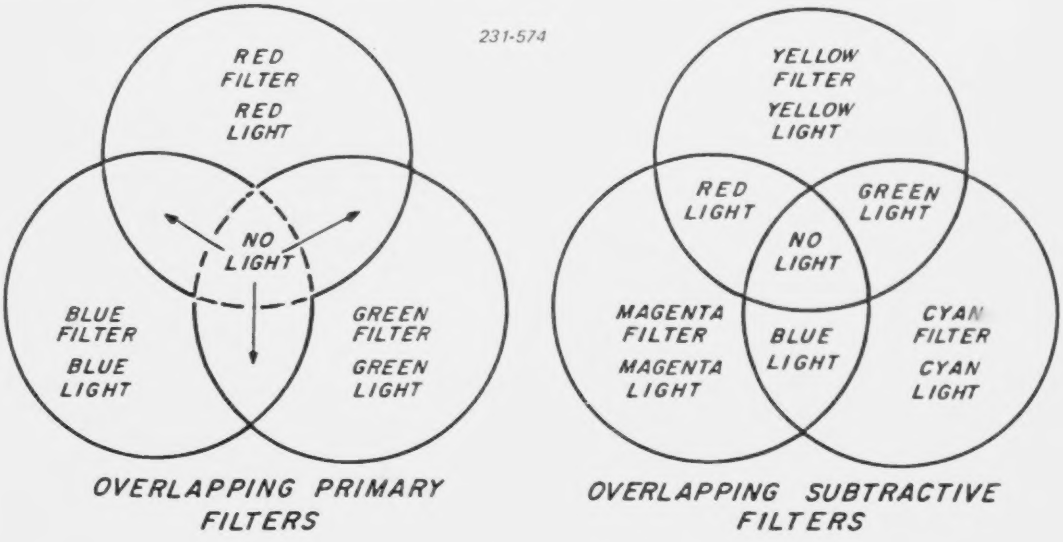
231-574
RED FILTER
RED LIGHT
NO LIGHT
BLUE FILTER
BLUE LIGHT
GREEN FILTER
GREEN LIGHT
OVERLAPPING PRIMARY FILTERS
YELLOW FILTER
YELLOW LIGHT
RED LIGHT
GREEN LIGHT
NO LIGHT
MAGENTA FILTER
MAGENTA LIGHT
BLUE LIGHT
CYAN FILTER
CYAN LIGHT
OVERLAPPING SUBTRACTIVE FILTERS

Figure 5-2. Additive and subtractive filters.

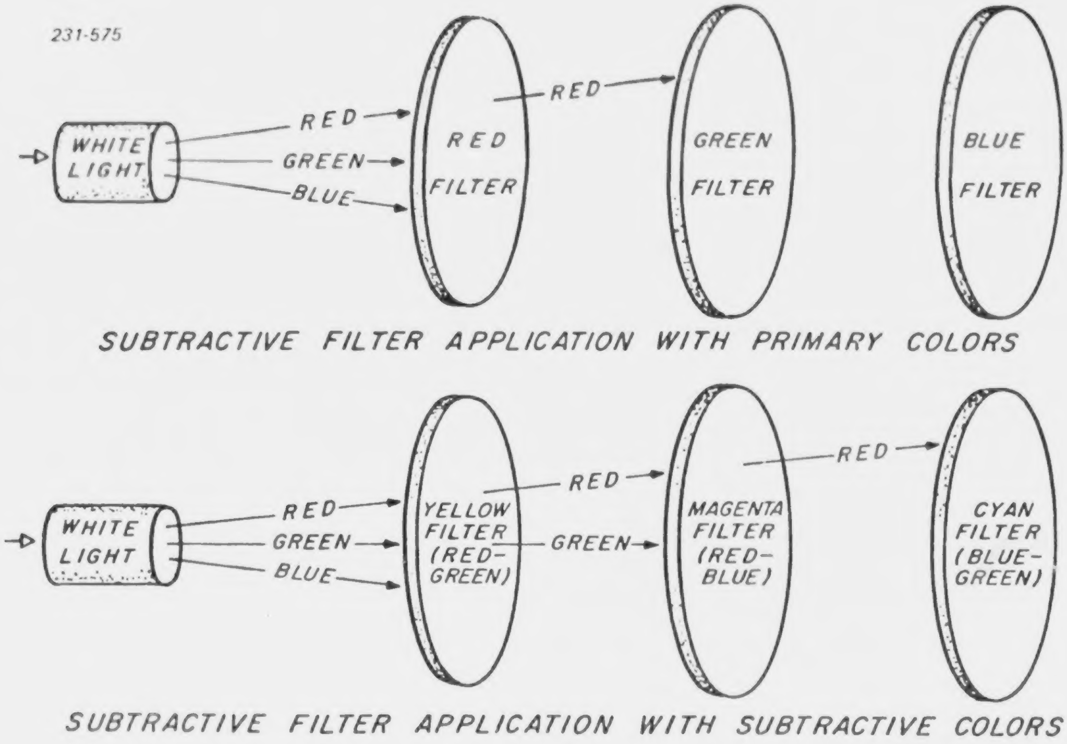
231-575
WHITE LIGHT
RED
GREEN
BLUE
RED FILTER
RED
GREEN FILTER
BLUE FILTER
SUBTRACTIVE FILTER APPLICATION WITH PRIMARY COLORS
WHITE LIGHT
RED
GREEN
BLUE
YELLOW FILTER (RED-GREEN)
RED
GREEN
MAGENTA FILTER (RED-BLUE)
RED
CYAN FILTER (BLUE-GREEN)
SUBTRACTIVE FILTER APPLICATION WITH SUBTRACTIVE COLORS

Figure 5-3. Filter application.

Limitations in Using Filters. You must realize that a filter must not be used indiscriminately. Film sensitivity has a great deal to do with which filters can be used. Orthochromatic film has no sensitivity to red. Using a red filter therefore would eliminate both the blue and the green, and no exposure would be obtained. The color of the illumination may also place limitations on the use of filters. If a subject is being illuminated with a pure blue light, neither red, green, or yellow filters should be used. When filters are being used, it is essential that you be completely familiar with both the sensitivity of the film you are using and the nature of the illumination.

NOTE: Our discussion has emphasized filter application in black and white photography. The same principles apply to color photography. The main difference is that filters for color photography emphasize the subtractive primary colors and are usually very pale in color.

Exercises (244):

1. What colors of light are absorbed and transmitted by the following filters or filter combinations?

   a. Blue

   b. Green and Yellow

   c. Red and Cyan

   d. Magenta

2. What filters would you not use if you had blue sensitive film in your camera? Why?

3. The thickness of the filter may cause what problem?

5-3. Filter Factor Computation

Unless you are using a very pale filter, you will need to increase your exposure when you are using a filter. To calculate the necessary increase you must understand filter factors—the subject of this section.

245. Solve exposure problems involving filter factors.

Since filters absorb light, the amount of exposure given with a filter must, in almost all cases, be greater than the exposure without a filter. How much the exposure must be increased depends upon the color and density of the filter, the color sensitivity of the film, the color of the illumination that falls upon the subject, and the reflective properties of the subject.

The exposure increase necessary for each filter is given as a filter factor number. You can obtain the specific filter factor for your film-filter combination by reading the data sheets supplied with the filter and film you are using. Then there are three methods that can be used to calculate your next exposure.

One way to use a factor is to divide the factor into the ASA or exposure index of the film you are using and then set your meter to this new figure. For example, with Kodak Tri-X Pan rated at ASA 400 and a light-green filter having a factor of 4, divide the filter factor into the film speed to calculate the new exposure index which is 100 (400 ÷ 4 = 100). Once you have set the meter at the new exposure index, you can use the meter in the normal manner. Remember, however, to reset the meter to the original ASA setting when you are not using the filter.

Another method of applying the filter factor is through the f/stop setting. Before applying this method, you must be thoroughly familiar with f/stop and their function in changing exposure. The following chart shows what the filter means when related to f/stops.

Filter Factor	2	4	6	8
Increase f/stop by	1	2	2½	3

As you can see from the chart, a filter factor of 2 would require a one stop increase (doubling of exposure) from the basic setting. This would mean that if your exposure was f/8 at 1/125 and you decided to use a yellow filter with a factor of 2 your new exposure would be f/5.6 at 1/125.

A third and perhaps the easiest method to compensate for the filter factor is to multiply the exposure time by the filter factor. For example, a basic exposure without a filter is 1/500 at f/8. After installing a filter with a factor of 4, the new exposure would be calculated as follows: 1/500 × 4/1 = 1/125. The f/stop would remain the same.

Filter factors serve only as guides. The factors vary from manufacture, even with filters that appear to be the same color. Since overexposure can kill the effect of a filter, it is a good idea to bracket your exposures by full stops to make sure you get a satisfactory result.

Exercises (245):

1. Calculate the correct exposure for each of the following filter problems.
   a. Suppose you are going to use a green filter with a factor of 4. What would your new shutter speed be if your basic exposure is f/11 at 1/500?
   b. You are going to use a filter with a factor of 2. What would your new f/stop be if your basic exposure is f/22 at 1/30?
   c. Now you are planning to use a filter with a factor of 8. What would your new exposure index be if you were using a film with an ASA of 320?

5-4. Correction Filters for Black and White

In this section you will learn how correction filters can help you achieve more natural tonal reproduction in your black and white work.

246. Identify from a list the correct filter/film combination that can be used to achieve orthochromatic rendition.

There are no black-and-white panchromatic emulsions with exactly the same color sensitivity as that of the human eye. The normal eye tends to be more sensitive to green, while panchromatic films are relatively more sensitive to blue or in some cases to red. The purpose of a correction filter is to absorb a portion of the color of the light to which the film is most sensitive. The film then reproduces the subject colors in shades of gray which, when printed, will correspond more closely to the way the eye would have rendered them. This type of result is called orthochromatic rendition.

The filter recommendations for correct rendering of subjects in black and white are ordinarily included in the film data sheets. The two filters recommended by Kodak for their panchromatic films are:

1. Daylight Lighting—No. 8 (K2)—Medium Yellow
2. Tungsten Lighting—No. 11 (X1)—Light Green

The medium yellow absorbs the excess blue that is found in daylight and to which the film is already very sensitive. This cuts down density in the sky area and, therefore, renders the sky a light gray (rather than white) in the print. The light green filter cuts down the excess red found in tungsten lighting.

NOTE: Blue sensitive and orthochromatic films cannot be used to achieve orthochromatic rendition because of their limited sensitivites.

Exercise (246):

1. Pick out which one of the following film/filter combinations can be used to achieve orthochromatic results in daylight lighting.
   a. Orthochromatic film and an orange filter.
   b. Panchromatic film and a red filter.
   c. Blue sensitive film and a red filter.
   d. Panchromatic film and a blue filter.
   e. Orthochromatic film and a yellow filter.
   f. Panchromatic film and a yellow filter.

5-5. Contrast Filters

Contrast filters are stronger than correction filters. Their purpose is to create tonal separation between two colors that otherwise would appear as the same shade of gray or to create exaggerated tonal effects. Proper use of contrast filters can make your black-and-white work more dramatic and interesting.

247. Describe the effect of using selected contrast filters in different shooting situations.

Contrast filters come in a variety of colors and densities. They are identified in different ways by their manufacturers. Let us discuss the effect that a variety of contrast filters have in black and white photography.

Yellow. A yellow filter, as has been mentioned, can be used as a correction filter. It is a minus blue filter which is used to make the sky appear darker in a print. Yellow filters can be found in light, medium, and dark densities. The darker the filter the more blue that is absorbed. The medium yellow filter is probably the best all around filter for daylight black and white photography.

Orange. An orange filter absorbs more blue than a yellow one, therefore, it produces dramatic (exaggerated) contrast between sky and clouds. It can be ideal for beach and snow scenes where greater filtration of blue may be desired. It is also effective for pictures of furniture made of yellowish woods like maple, oak, or walnut.

Red. A red filter is a very strong primary filter. It absorbs a great deal of blue. It can create spectacular cloud shots as it can render the sky almost black on the print. For the same reason, it is good for architecture shots of light-tone buildings as they can be made to stand out dramatically against a darkened sky. "Fake" night shots can be made by underexposing with the red filter. A red filter (along with orange) is not usually suitable for portraiture, particularly of women, as it leads to chalky skin tones.

Green. A green filter is excellent for outdoor scenes as it increases the contrast between sky and clouds and lightens foliage, bringing out greater detail. In flower photography it is effective because it often lightens the leaves while darkening the flowers. A green filter is best for outdoor portraiture as it renders skin tones correctly. It can also be used to render the red lipstick of a girl darker.

Blue. A rarely used filter as it increases the density of blue relative to the other primary colors. It is used occasionally to create a "hazy" sky which can have pictorial value as it produces a greater feeling of depth.

Filters are very effective tools in black and white photography. They can create effective tonal differences that could otherwise only be accomplished by very tedious printing techniques. Look at figures 5-4, 5-5, 5-6, 5-7, and 5-8 to see how subjects can be rendered using different filters. Filters are easy to use. You can examine the scene through the filter to get some idea of its effect. Through practice you will know which filter will help you get the result you want.

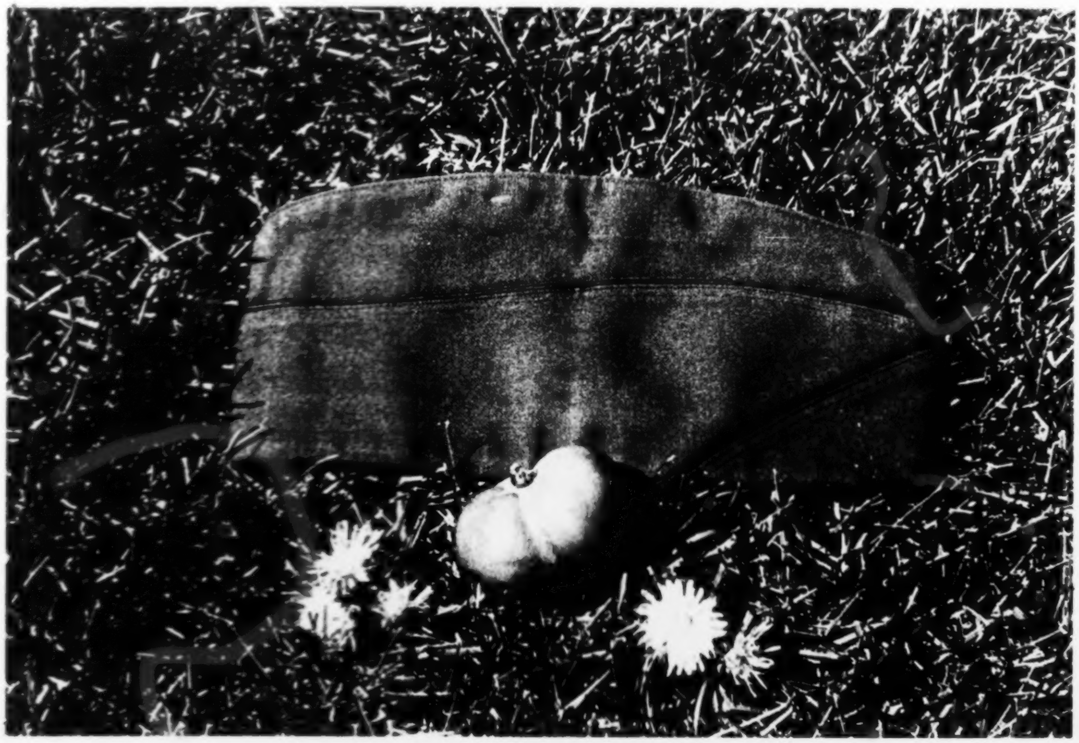

Figure 5-4. Normal picture.

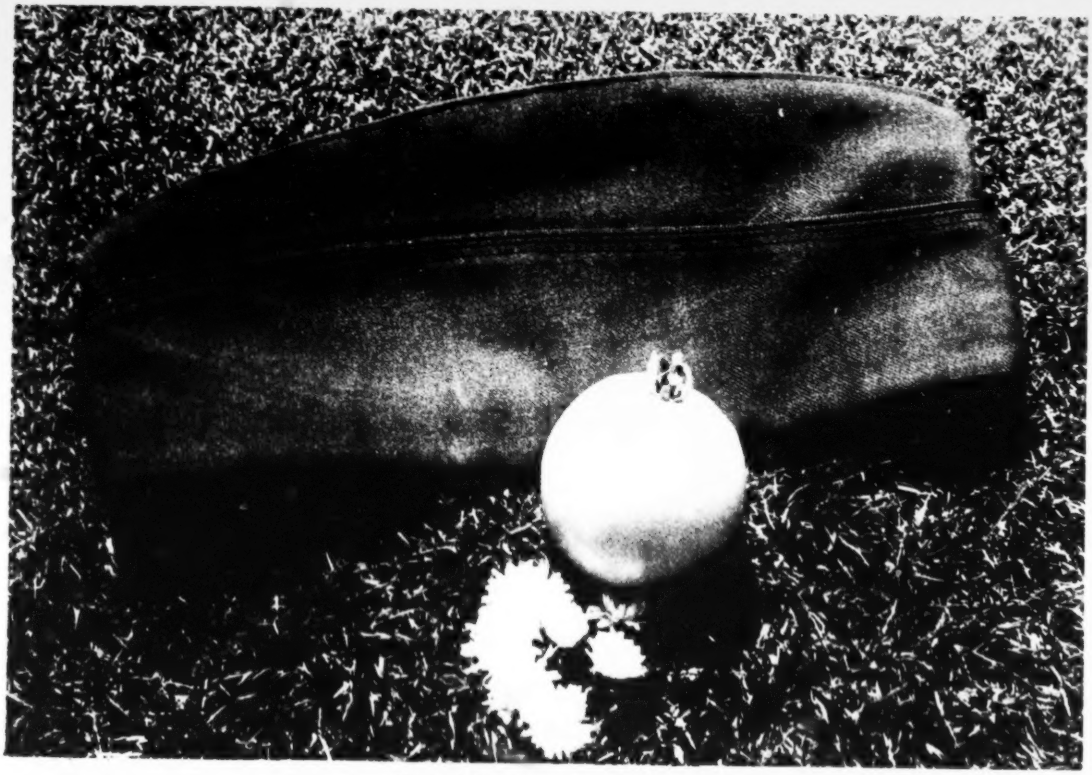

Figure 5-5. Picture with red filter.

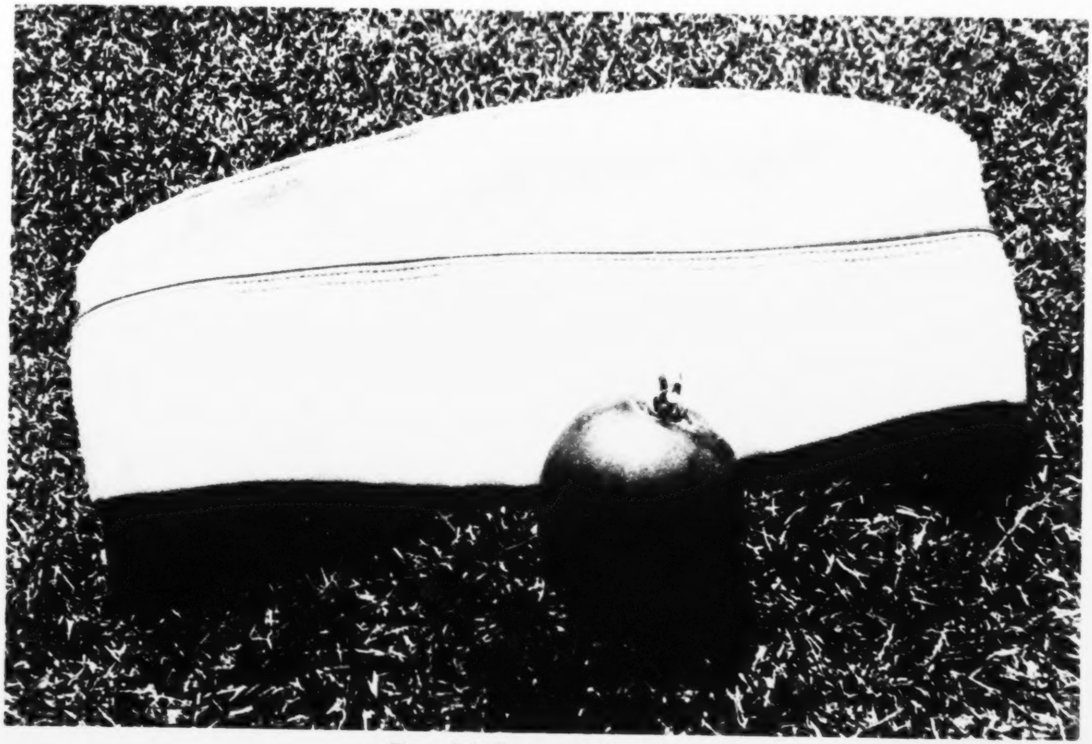

Figure 5-6. Picture with blue filter.

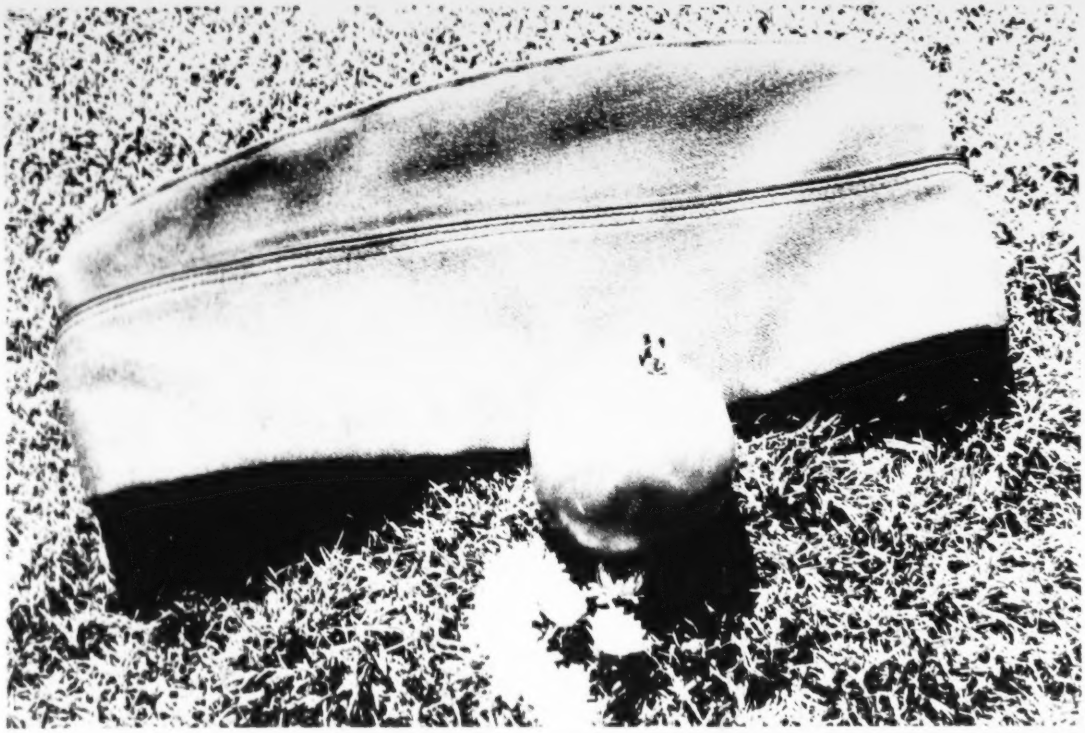

Figure 5-7. Picture with green filter.

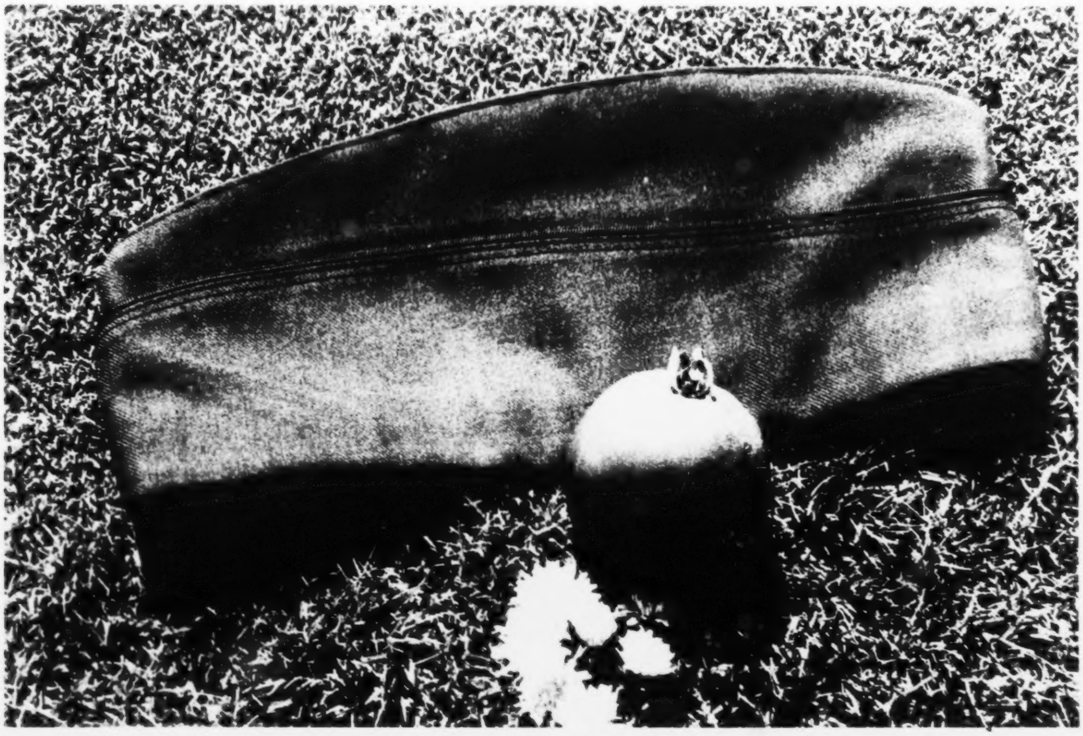

Figure 5-8. Picture with yellow filter.

Exercise (247):

1. Describe the final photographic print effect of using a given filter in each of the following situations.
   a. You are photographing a red rose using a red filter.

   b. You are using a green filter when photographing a meadow on a sunny day.

   c. You use an orange filter when photographing the White House on a clear day.

   d. Today you photograph a mountain scene with a blue filter.

5-6. Neutral Density Filters

Neutral density filters are another type of filter you should become familiar with. A neutral density filter can help you when you encounter high intensity lighting situations or when you want to achieve certain compositional effects.

248. Briefly explain what a neutral density filter does and how it can be used.

Neutral density (ND) filters come in different densities of gray. They are used to control the intensity, rather than the color, of light striking the film. There are two basic shooting situations where a neutral density filter comes in handy. The first is where the light intensity is so strong that overexposure will result with the film that is being used. For example, your camera may be loaded with film rated at 1,000 ASA and you find yourself shooting at the beach on a sunny day. Even if you use the highest shutter speed and the smallest aperture your camera has you still overexposed. The second situation is when the light is too strong for slow shutter speeds or large aperture settings that may be important for compositional reasons. For example, you may need a large aperture to achieve limited depth of field when shooting a portrait or a slow shutter speed to give the feeling of speed when shooting an auto race. If it is a bright sunny day and you have a moderate (ex. 400 ASA) speed film in your camera, your selection of shutter speed and f/stop combinations may be limited. A neutral density filter in these situations can be used to prevent overexposure.

Neutral density filters are usually identified by their density or filter factor. Here is an abbreviated list of available neutral density filters.

Density	*Percent of Light Transmitted*	*Filter Factor*
~~0.030~~ 0.30	50%	2
0.60	25%	4
0.90	13%	7.7
1.30	5%	20
2.00	1%	100

Exercises (248):

1. Briefly explain the purpose of a neutral density filter.

2. Briefly explain two situations where a neutral density filter can be used.

5-7. Polarizing Filters

A polarizing filter is applicable to either black and white or color photography. It has very specialized applications that can help you get better pictures. Let us learn how a polarizing filter works.

249. Define polarized light and explain the purpose of a polarizing filter and how it works.

To put a polarizing filter to work it pays to understand how light travels. Light rays travel in straight lines and vibrate in all directions perpendicular to their direction of travel. If a light ray hits a nonmetallic surface, the vibrations in only one direction are reflected completely. A light ray vibrating in only one direction is considered polarized.

A polarizing filter consists of a plastic polarizing sheet between two sheets of glass in a rotatable mount. The filter allows full transmission of light waves oriented in one plane only. It therefore *polarizes* the light it *transmits*. Light attempting to pass through the filter at any other angle is attenuated or extinguished. If the light striking the filter is polarized, and the axis of the filter is oriented at 90° to the plane of that light, none of it can pass through the filter.

The filter is mounted in front of the lens, and its effect can be seen through the reflex finder or ground glass. (With a rangefinder camera you can rotate the filter in front of your eye, and once the proper result is achieved, insert the filter to match that position.) By rotating the filter, you rotate axis of polarization. If the plane of reflected light is at right angles to the axis of polarization of the lens, the reflection can be suppressed or eliminated.

The filter is excellent for reducing the glare from water, glass, oil paintings, and glossy photographs. (See figs. 5-9 and 5-10.) The reduction of glare greatly enhances detail and color saturation. The same can happen with a blue sky which is made up of a lot of unpolarized light. With the sun, camera, and sky forming a right angle, the camera at the vertex, the maximum polarization of the blue sky takes place, and

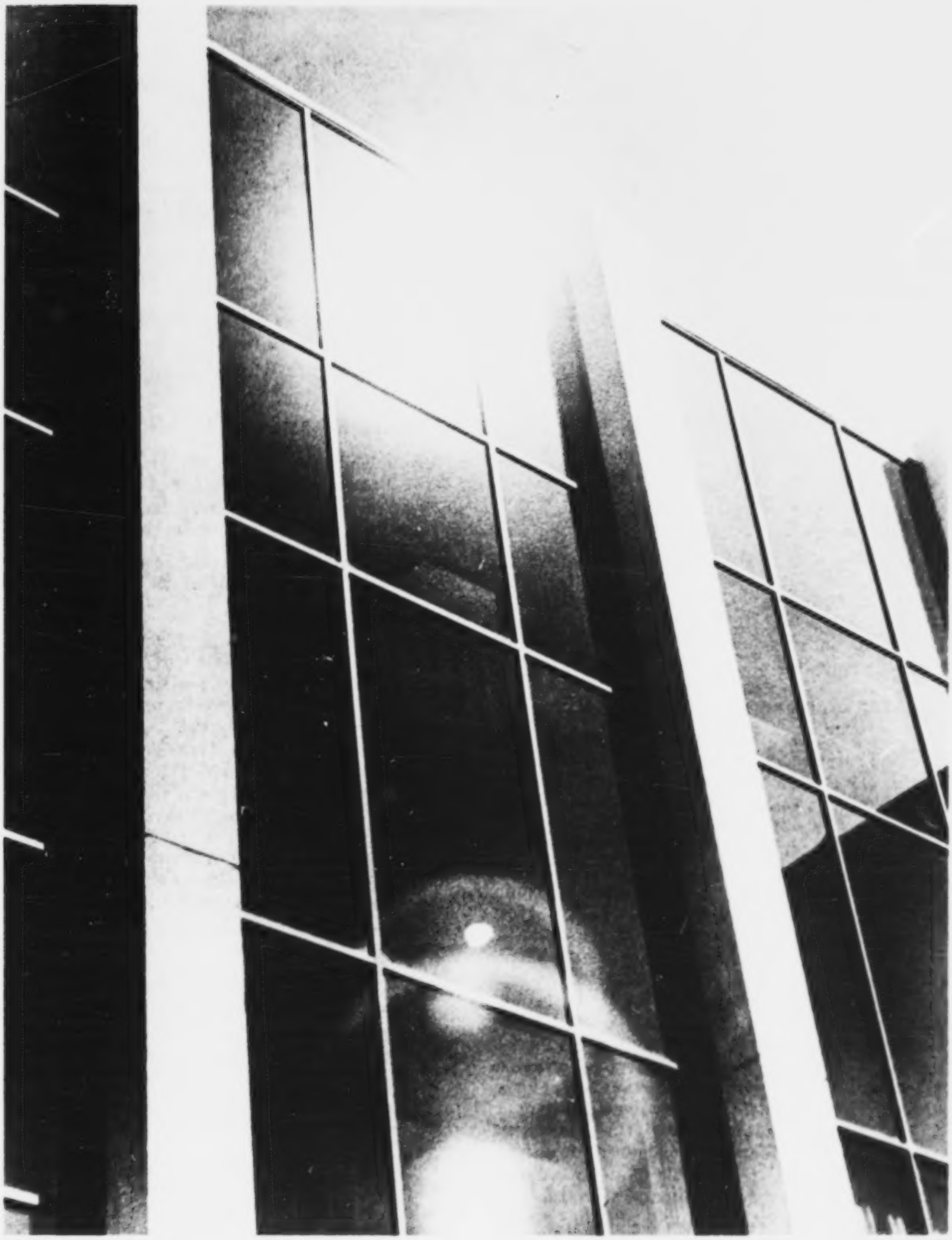

Figure 5-9. Normal picture.

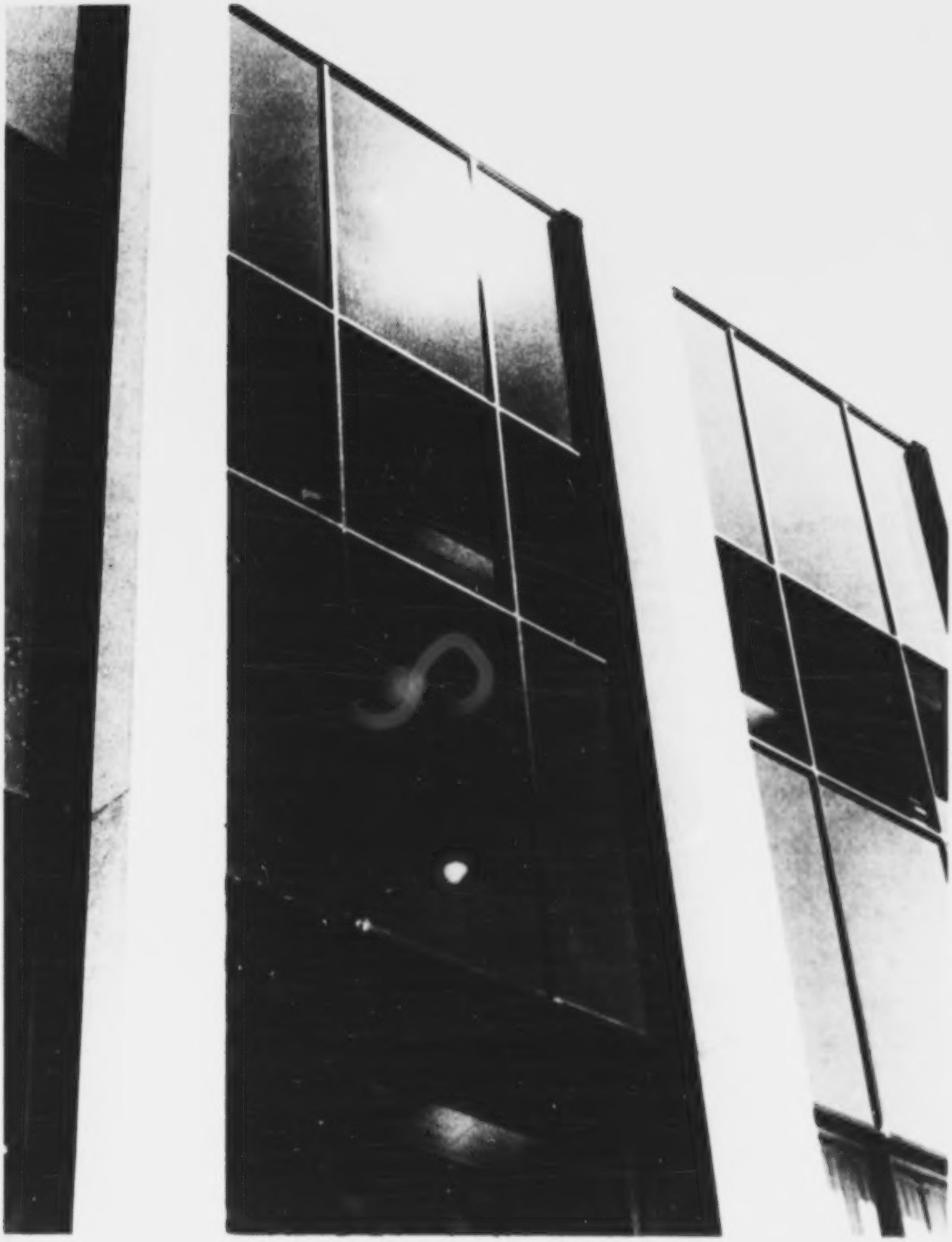

Figure 5-10. Picture with polarizing filter.

consequently the maximum darkening of the sky can be achieved without darkening the tone or colors in the rest of the shot. If the camera is pointed towards the sun or 180° from it, there is no such effect. A polarizing filter has a factor of about 2.5. If used with another filter you should ~~multiply~~ add the filter factors together to get a new one to work with. When not used for polarizing, the filter acts as a neutral density filter.

Exercises (249):

1. What is polarized light?

2. What does a polarizing filter do to polarized light and to nonpolarized light?

3. A polarizing filter is used on what kind of subjects?

5-8. Haze Penetrations

Haze is a problem in all outdoor daylight photography. Haze causes an overall bluish cast in color photographs, and lowers contrast in both black-and-white and color photos. This is because moisture and particles in the air scatter light as it passes through the atmosphere. The blue portion of the spectrum is affected most. Haze is a problem in scenic and aerial photography (particularly important to the Air Force). Filters and certain filter/film combinations are helpful in fighting this basic photographic problem.

250. Explain how certain filter/film combinations can penetrate haze.

Black-and-White Panchromatic Film. Due to the excess blue found in hazy conditions, a yellow, orange, or red filter coupled with panchromatic film is best suited for the job. The choice of filter depends on how bad the haze is. The darker the filter the more haze penetration, but a darker filter requires increased exposure. For example, a red filter gives good haze penetration but has a filter factor of about 8. A medium yellow or orange may prove the best for general outdoor scenics. A red might prove best for aerial work.

Black-and-White Infrared Film. Infrared film provides better haze penetration than panchromatic film because it can record the haze penetrating infrared rays that are longer than visible red. A dark red filter (Wratten 29 or 70) should be used to absorb the ultraviolet and blue rays of light. Exposure should be well bracketed to insure adequate density since ordinary exposure readings will not work.

Color Film. There are three basic filters that can reduce haze in color films: Skylight, UV, and Haze. A Skylight filter (light pink in color) absorbs ultraviolet and some excess blue. A UV filter (yellowish tint) also absorbs ultraviolet and excess blue, but may add a slight overall yellowish cast to the picture. A Haze filter is practically clear and absorbs some of the ultraviolet rays without making much of a color shift.

NOTE: These three filters require no change in exposure because of their very pale nature. They also may be used with black-and-white films. A photographer often leaves one of these filters in place over the lens at all times for protection of the lens and absorption of ultraviolet light.

Color Infrared. Color infrared has good haze penetrating characteristics and is increasingly used in reconnaissance photography. The film can also be used for striking pictorial effects. When using color infrared it is recommended that you use a deep yellow filter. When this is done green foliage comes out magenta, but clouds are white and the sky is blue. Other filters can be used but the colors are very distorted (i.e. with a red filter the sky is rendered green, clouds are yellow and foliage is orange).

NOTE: This is the only color film where filters designed for black-and-white photography are recommended.

Exercises (250):

1. Why is the use of panchromatic film with a red filter a good haze cutting combination?

2. What is the advantage of using infrared film to cut through haze?

3. Why is a red filter used with black-and-white infrared film?

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Stroebel, Leslie and Todd, Hollis N. *Dictionary of Contemporary Photography*. New York: Morgan and Morgan, 1977.

Swedlund, Charles. *Photography*. New York: Holt, Rinehart and Winston, Inc., 1971.

NOTE: None of the items listed in the bibliography above are available through ECI. If you cannot borrow them from local sources, such as your base library or local library, you may request one item at a time on a loan basis from the AU Library, Maxwell AFB, AL 36112, ATTN: ECI Bibliographic Assistant. However, the AU Library generally lends only *books* and a limited number of *AFMs*. TOs, classified publications, and other types of publications are not available. Refer to current indexes for the latest revisions of and changes to the official publications listed in the bibliography.

ANSWERS FOR EXERCISES

CHAPTER 1

Reference:

200 - 1. 1. Light.
2. It is reflected.
3. Transparent.
4. It is absorbed.
5. Refracted.
6. Reflection; absorption.

201 - 1. a. Direct sunlight diffused through the earth's atmosphere.
b. Light reflected from the sky.
c. Light reflected from objects on the earth's surface.

201 - 2. a. Geographic location.
b. Time of day.
c. Season of the year.
d. Weather conditions.

201 - 3. a. Flatlighting - subject faces the sun.
b. Backlighting - camera faces the sun.
c. Open shade - subject in a shaded area, with the sky as background.

202 - 1. 1. Lower output and color quality.
2. Yes. Don't overload circuits. Don't splash water on them. Keep them away from combustible materials.
3. Natural.
4. From the main lamp.

203 - 1. a. Portability.
b. Extremely short flash duration.

203 - 2. a. Minimizes the adverse effects of camera and subject movement.
b. Eliminates need for hot lights, used in portrait making.

203 - 3. Yes. It fills in shadows, stimulates sunlight under hazy skies, and approximates natural sunlight conditions.

204 - 1. c, d, e, f, h.

205 - 1. a. Phosphor. It converts ultraviolet light to visible light.
b. Longer than 1/60 second. Florescent lights pulse [illegible] 60 times every second.
c. Green. When using color film.

CHAPTER 2

206 - 1. The formula for photographic exposure is E = I × T.

206 - 2. The two factors that determine exposure are the intensity of the exposing light and the amount of time it is allowed to strike the film.

207 - 1. a. 1/250 at f/4.
b. 1/60 at f/11.
c. 1/250 at f/4.

208 - 1. The law of reciprocity is expressed in the formula, E = I × T. This formula means that if the product of the light intensity and the time of the light action is the same for each exposure, then each sheet of film having the same film speed will have the same density when processed the same.

208 - 2. When you have conditions of extremely high or low intensitieis, normally marked by extremely short or long exposure times, you will have reciprocity failure.

208 - 3. Reciprocity failure results in a loss of film speed which causes underexposed negatives.

209 - 1. The scene brightness range is the difference between a scene's highlights and its shadows.

209 - 2. The scene brightness range sets the contrast of the scene. If the contrast is beyond the limits of the film that is being used, shadow detail will be lost or highlights blocked up as an attempt is made to expose for this range of highlights and shadows.

210 - 1. a. f/22.
b. f/5.6.
c. f/5.6.

211 - 1. a. f/16.
b. 10 feet.
c. 10 feet.
d. f/8.

212 - 1. a. True.
b. False. Incident light meters do not consider the tone value of the subject at all.
c. False. Point the light-gathering receptor toward the camera.
d. True.
e. True.
f. False. A flash meter can compute exposure for more than one flash unit or bounce flash.
g. True.

213 - 1. Cover the photoelectric cell opening. (With some meters you must remove the batteries.)

213 - 2. Yes. High intensities may cause the indicator needle to bounce at the high end of the scale and eventually cause damage to the unit.

213 - 3. Keep it in the carrying case and away from heat (125° F 51.7° C).

213 - 4. Pointing it at the sun.

214 - 1. a. True.
b. False. Change "an incident" to "a reflected."
c. True.
d. False. Change "at a 45° angle to the subject" to "perpendicular to the ground."

CHAPTER 3

215 - 1. a. Overcoating.
b. Emulsion.
c. Two.
d. Film base.
e. Culring; halation.

216 - 1. a. Film; processing.
b. Middle tones.
c. Slow; even.

217 - 1. All silver halides are sensitive to ultraviolet, violet, and blue.

217 - 2. Optical sensitization is the method used to increase the sensitivity of an emulsion by dyeing or staining the silver halide crystals.

217 - 3. Panchromatic film.

218 - 1. The ability of an emulsion to record a range of subject brightnesses is called film latitude.

218 - 2. Exposure latitude is directly related to the film's inherent latitude. If the film has wide inherent latitude, it will also have wide exposure latitude.

218 - 3. Latitude in black-and-white film is related to film speed.

219 - 1. American National Standards Institute (ANSI).

219 - 2. a. Exposure.
b. 200.
c. Density.
d. Slowest.
e. Slow.

220 - 1. Contrast is the difference between high and low densities of a negative.
220 - 2. A normal contrast negative will have a full range of densities, including highlights, middle tones, and shadows.
220 - 3. Slow speed films usually have the highest inherent contrast.
220 - 4. Generally, the more development, the more the contrast.

221 - 1.
    a. Many.
    b. Exposure.
    c. Speed; high.

222 - 1. Since orthochromatic film is not sensitive to red and is sensitive to only blue and green it is limited to subjects that do not have a full range of colors.

223 - 1. c; d; f.

224 - 1.
    1. c.
    2. h.
    3. e.
    4. d.
    5. f.
    6. a.

225 - 1. Red.
225 - 2. Haze.
225 - 3. Increased.
225 - 4. Heavy.

CHAPTER 4

226 - 1. Focal length is the distance from the optical center of the lens to the image produced at the focal plane when the lens is focused on infinity (a condition that exists when light rays from distant objects enter the lens in a nearly parallel attitude).

227 - 1. In the formula, $f = \frac{FL}{D}$ f is f/stop; FL is focal length; and D is diameter.
227 - 2. A fast lens has a wide maximum aperture.
227 - 3. A slow lens has a small maximum aperture.
227 - 4. An f/4, 100mm lens is slower than an f/2, 100mm lens because the f/4 lens has a smaller maximum aperture.

228 - 1. The circle of illumination is the total light proejcted by a lens.
228 - 2. The usable circle of illumination is that part of the circle of illumination that is bright enough to produce usable images.

229 - 1. The angle of field of a lens is the widest angle at which light enters the lens and produces the usable portion of the circle of illumination. The angle of view is the angle of light that is necessary to provide adequate coverage of the film that is being used. It may be equal to but is never greater than the angle of field.

230 - 1. Resolution refers to the ability of a photographic lens or material to record fine detail. The normal method of measuring this quality is to photograph a suitable test pattern at a greatly reduced scale, and then examine the developed image under adequate magnification to calculate the smallest detail.
230 - 2. Definition refers to the quality aspect of a photograph that is associated with the clarity of detail. It is a subjective evaluation based on an observer's view of the photograph.

231 - 1. The purpose of coating a lens is to improve light transmission and reduce optical flare.
231 - 2. The lens should be cleaned with the proper tools. These include: a fine brush, lens tissue, and lens cleaning solution. Throughout the process of dusting, cleaning, and polishing there should be no undue pressure that would "rub-off" the lens coating.

232 - 1. A normal lens has a focal length that is about equal to the diagonal dimension of the film being used.

233 - 1.
    a. Shorter.
    b. Smaller.
    c. Depth of field.
    d. Center; edges.

234 - 1. A long focal length lens has a focal length greater than the diagonal dimension of the film.
234 - 2. The narrower angle of coverage and the larger image size for a given subject-to-camera distance produced by a long-focal-length lens isolates the subject from its surroundings. A short-focal-length lens has much wider coverage and, thus, a problem of creating a strong point of interest.
234 - 3. Long-focal-length lenses magnify camera shake, and it is necessary to use high shutter speeds to correct this problem.

235 - 1.
    a. True.
    b. True.
    c. False.
    d. True.
    e. False.

236 - 1. You can change focal lengths without changing lenses when you use a zoom lens.
236 - 2. One disadvantage of a zoom lens is that they do not produce extremely sharp images.

237 - 1. The two controls that determine image size are: (1) the focal length of the lens that is used and (2) the lens-to-subject distance. The longer the focal length, the larger the image size. The closer the lens-to-subject distance, the larger the image size.

238 - 1. Perspective is the impression of depth when a 3-dimensional scene is represented in a 2-dimensional photograph.
238 - 2. Focal length does not change perspective. It changes your perception. Changing focal length changes the relative size of your subjects, but they are still in the same relationship to each other.

239 - 1. Depth of field is the zone extending in front of and behind the point in sharpest focus.
239 - 2.
    1. Focal length. Short focal length lenses have greater depth of field.
    2. Lens to subject distance, the farther away an object is from the lens, the greater the depth of field.
    3. Aperture. A small f/stop will increase the depth of field.
239 - 3. Focus 2 feet into a 5-foot subject to insure adequate depth of field.
239 - 4. Hyperfocal distance is the distance from the lens to the nearest phone that is in acceptable focus when the lens is focused on infinity. Each f/stop has a different hyperfocal distance.

240 - 1. Depth of focus is the zone or area within which the film can be moved and still be in focus.

241 - 1. Critical aperture is the aperture of a lens that produces the sharpest image. It is usually two f/stops from wide open.

242 - 1. Mechanical flare is caused by reflections that occur off the lens barrel or camera. These reflections are usually caused because a metal surface has been damaged or burnished. The method of correction is to coat these surfaces with a nonreflective coating.
242 - 2. Optical flare is caused by reflections off the glass surfaces of the lens. Such flare can be reduced or eliminated by a proper lens coating and the use of a lens shade.

CHAPTER 5

243 - 1. The two advantages in using gelatin filters are that they are inexpensive and come in a wide variety of colors.

243 - 2. Glass filters are quite durable as compared with gelatin filters.

243 - 3. All filters fade in time and have to be replaced.

244 - 1. a. A blue filter transmits blue and absorbs green and red light.
  b. A combination of a green and yellow filter would transmit green and absorb red and blue.
  c. The complementary combination of red and cyan would abosrb all colors of light.
  d. Magenta would pass red and blue and absorb green light.

244 - 2. Red, green, and yellow filters should not be used with blue sensitive film, since it is sensitive only to blue and ultraviolet light. Any filter that would completely absorb blue would be unsuitable.

244 - 3. The thickness of the filter can cause focusing problems. The thicker the filter, the greater the alteration to the light waves. It is therefore best to focus with the filter in place.

245 - 1. a. 1/125.
  b. f/16.
  c. ASA 40.

246 - 1. f.

247 - 1. a. The rose appears light and the green leaves appear quite dark.
  b. Using a green filter gives the sky a more natural tone and produces more detail in the grassy meadow.
  c. The orange filter causes the sky to appear quite dark and the White House to stand out to a greater degree.
  d. The blue filter causes the sky to appear quite light and hazy with little detail. This can give quite a feeling of depth.

248 - 1. The purpose of a neutral density filter is to cut down the intensity of the light striking the film without changing its color quality.

248 - 2. By using a neutral density filter you can prevent overexposure when you are using a high-speed film in a high-intensity lighting situation, and you may be able to select large aperture settings or slow shutter speeds for compositional reasons and yet not be overexposure.

249 - 1. Polarized light is light that is vibrating in only one direction.

249 - 2. A polarizing filter blocks polarized light that is perpendicular to it. The filter polarizes nonpolarized light.

249 - 3. A polarizing filter is used to cut down reflections from nonmetallic surfaces and to darken blue skies.

250 - 1. In a hazy situation you have an excess of blue. A red filter absorbs blue to a greater degree than other filters, and therefore permits a greater percentage of haze cutting red wavelengths of light from the image on the film.

250 - 2. Infrared film is sensitive to infrared waves that are longer than red. The longer wavelengths of light are better able to cut through haze. This results in greater detail.

250 - 3. A red filter is used with infrared film to absorb blue and ultraviolet wavelenths. This insures that the image will be formed by red and infrared wavelengths.

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STOP - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE

23132 02 22

STILL PHOTOGRAPHIC FUNDAMENTALS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover your answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you have to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If mandatorily enrolled student, process questions or comments through your unit trainer or OJT supervisor. If voluntarily enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: **NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE.** In parenthesis after each item number on the VRE is the Learning Objective Number where the answer to that item can be located. When answering the items on the VRE, refer to the Learning Objectives indicated by these Numbers. The VRE results will be sent to you on a postcard which will list the actual VRE items you missed. Go to the VRE booklet and locate the Learning Objective Numbers for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

Multiple Choice

1. (200) Light rays that are bent as they pass through a medium are

   a. absorbed.
   b. refracted.
   c. dispersed.
   d. reflected.

2. (200) When light strikes a surface, all of the following can occur except

   a. transmission.
   b. absorption.
   c. conversion.
   d. reflection.

3. (201) What is your major problem with using open shade illumination?

   a. Eye squinting.
   b. Exposure computation.
   c. Light diffusion.
   d. Cluttered background.

4. (202) Regular household lamps are not generally used for photography because they have insufficient

   a. heat.
   b. color.
   c. infrared rays.
   d. output.

5. (202) When you are using more than one lamp to light your subject, the lamp pointed at the back of the subject provides

   a. hair light.
   b. fill light.
   c. main light.
   d. halo light.

6. (203) Which one of the following is not an advantage of electronic flash?

   a. The weight is less.
   b. Electronic flashes provide more light.
   c. Exposures need not be computed.
   d. Short duration can stop action.

7. (204) Which one of the following characteristics are associated with quart~~z~~ ~~iodine~~ lamps?
   halogen

   a. Constant color quality.
   b. Ability to stop action.
   c. Cool burning.
   d. Can be handled with bare hands.

8. (205) When you are using fluorescent lights your shutter speed should be

a. calculated at the subject.
b. longer than 1/60 second.
c. disregarded since fluorescent lights pulse.
d. determined with a green filter over the light meter aperture.

9. (206) In the exposure formula, E = I X T, if E equals exposure, what does I and T equal?

a. Illumination and time.
b. Interval and time.
c. Intensity and time.
d. Intensity and temperature.

10. (206) One unit of light falling on a piece of film for ten seconds is the same as 2 units of light falling on the film for

a. 2 seconds.
b. 3 seconds.
c. 5 seconds.
d. 7 seconds.

11. (207) In the exposure formula, E = I X T, which camera control determines I?

a. Lens.
b. Shutter.
c. Diaphragm.
d. Bellows.

12. (207) Additional light will strike the film in a camera when the

a. f/stop is moved down.
b. f/stop is moved substantially upward.
c. diaphragm is "closed down a stop."
d. Shutter speed is increased.

13. (207) Refer to figure 2-2. Which one of the following exposure combinations is the same as f/8 at 1/100?

a. f/5.6 at 1/50.
b. f/11 at 1/250.
c. f/16 at 1/25.
d. f/22 at 1/2.

14. (208) What is the effect of reciprocity failure?

a. Negatives will be overexposed.
b. Inherent grain will increase.
c. A gain in negative density.
d. An apparent loss of film speed.

15. (208) When will reciprocity failure most likely happen?

a. At extremely long or short exposures times.
b. After the film has been stored in a freezer.
c. Under extra bright lighting conditions.
d. During the early morning hours of the day.

16. (209) The relative difference between the brightest and darkest areas of a subject is called

a. shadow ratio differences.
b. scene brightness range.
c. brightness ratio range.
d. highlight contrast factor.

17. (209) What lighting ratio can most films handle before you get a washed out highlight?

a. 1:100.
b. 1:128.
c. 1:200.
d. 1:260.

18. (210) What two factors are used to calculate exposures?

a. Film speed and development time.
b. Film speed and subject brightness.
c. Lens diaphragm and lens speed.
d. Subject brightness and diaphragm size.

19. (210) When using an exposure guide chart and a film with a film speed of 125, what shutter speed should you use?

a. 1/25.
b. 1/50.
c. 1/125.
d. 1/250.

20. (211) Exposure for flash photography is based on what two factors?

a. Output of flash and subject speed.
b. Guide number and f/stop.
c. Film speed and shutter speed.
d. Output of flash and distance to subject.

21. (211) If the guide number for your electronic flash is 160 and the flash is 10 feet from the subject, what is the proper f/stop?

a. 16.
b. 22.
c. 32.
d. 45.

22. (212) Incident light meters measure the light that

a. is reflected from the subject.
b. the neutral gray card reflects.
c. cannot be measured at the camera position.
d. falls on the subject.

23. (212) When you use an incident light meter you should point the receptor toward the

a. camera.
b. subject.
c. sun.
d. gray card.

24. (212) Which one of the following is not a method of taking reflected light readings?

a. Average.
b. Brightness range.
c. Substitute.
d. Spotting.

25. (212) If you cannot approach your subject to take a light reading, which one of the following methods should you use?

a. Average.
b. Brigtness range.
c. Substitute.
d. Spotting.

26. (213) When you operate an exposure meter you should not

a. clean the glass over the cell.
b. point the cell toward the sun.
c. cover the cell to zero the meter.
d. check for sticky needle movement.

27. (214) What percentage of the incident light does the gray side of a neutral density gray card reflect?

a. 10 percent.
b. 18 percent.
c. 50 percent.
d. 90 percent.

28. (214) One way of compensating for readings taken from the white side of neutral-test card is to divide the ASA of the film by

a. 90.
b. 18.
c. 10.
d. 5.

29. (215) What is the purpose of the film's overcoating?

a. Protect the emulsion during handling.
b. Hold the silver crystals in place.
c. Bond the emulsion to the base.
d. Prevent halos around the bright objects.

30. (216) What causes grain in a negative?

a. Clumping of silver halides.
b. Lengthy storage periods.
c. Failure of the overcoating.
d. Long exposure times when printing.

31. (217) In a normally prepared emulsion, the silver halides are sensitive to all of the following except

a. ultraviolet.	c. infrared.
b. violet.	d. blue.

32. (218) What is it that allows you to use several possible exposures and still get acceptable negatives?

a. Scene brightness range.
b. Exposure latitude.
c. Inherent grain.
d. Narrow film speed.

33. (219) If you were using a film with an ASA of 100 and your exposure was f/8 at 1/50, what is your exposure if you change to a film with ASA 200?

a. f/8 at 1/100.	c. f/11 at 1/250.
b. f/11 at 1/125.	d. f/16 at 1/200.

34. (219) For which one of the following situations should you use a high-speed film?

a. An outdoor portrait.
b. A brightly lit snow scene.
c. Copy work of a white subject.
d. Indoors where a flash cannot be used.

35. (220) Which one of the following has no bearing on the contrast of a negative?

a. Shutter speed.
b. Subject lighting.
c. Film development.
d. Inherent contrast.

36. (220) What type of film emulsion usually has the highest inherent contrast?

a. High speed.
b. Low speed.
c. Daylight.
d. Tungsten.

37. (221) Which of the following charateristics are generally associated with high-resolution films?

a. Slow speed and high contrast.
b. Slow speed and low contrast.
c. High speed and high contrast.
d. High speed and low contrast.

38. (222) An orthochromatic film is least sensitive to

a. blue color.
b. green color.
c. violet color.
d. red color.

39. (223) What type of emulsions most closely match the sensitivity of the human eye?

a. Color blind.
b. Orthochromatic.
c. Panchromatic.
d. Infrared.

40. (224) The positive image in the Polaroid materials is produced by a process known as

a. conversion viscosity.
b. diffusion transfer.
c. positive development.
d. displacement monobath.

41. (225) In order for infrared film to properly record the scene, what filter must you use over the lens?

a. Deep green.
b. Light yellow.
c. Deep red.
d. Light blue.

42. (226) The distance from the optical center of the lens to the focal plane when the lens is focused on infinity is called the

a. hyperfocal distance.
b. focal point.
c. conjugate distance.
d. focal length.

43. (227) Which one of the following is the formula for determining the speed of a lens?

a. $f = FL/D$.
b. $f = D/FL$.
c. $S = f/D$.
d. $S = D/f$.

44. (228) The circle of illumination is

a. all of the light projected by a lens.
b. controlled by the photographer.
c. used only on view cameras.
d. brighter at the edges than in the center.

45. (229) The maximum coverage of a lens is expressed in degrees as being the

a. focal length.
b. angle of field.
c. optical coverage.
d. angle of acceptance.

46. (230) The capability of a lens to record fine detail is called

a. accuteness.
b. abberation.
c. granularity.
d. resolution.

47. (231) The purpose for coating a lens is to

a. keep it from being tarnished.
b. minimize internal reflections.
c. make the lens slower.
d. help reduce surface scratches.

48. (232) The focal length of a "normal" lens is equal to the

a. diagonal dimension of the film.
b. length times the width of the film.
c. circle of illumination divided by the speed of the lens.
d. circumference of the lens times the aperture.

49. (233) Which one of the following is not a characteristic of a wide angle lens?

a. Short focal length.
b. Good depth of field.
c. Usable in cramped areas.
d. Large image size.

50. (234) A long-focal-length lens will

a. produce a small image size.
b. increase the depth of field.
c. produce a large image size.
d. change the center of perspective.

51. (234) Which one of the following statements is true regarding long focal length lenses?

a. The focal length of a long focal length lens is usally shorter than the diagonal dimension of the film.
b. You must use slow shutter speeds with a long focal length lens.
c. The depth of field is greater with a long focal length lens.
d. The size and weight of the long focal length lens will sometimes require a tripod.

52. (235) Which one of the following statements is true regarding telephoto lenses?

a. They are designed the same way as long-focal-length lenses.
b. You must use a slow shutter speed when using telephoto lenses.
c. A negative rear element is used to achieve the long effective focal length.
d. You cannot use a telephoto lenses on small format cameras.

53. (236) What type of lens allows you to change focal length without changing lenses?

a. Zoom.
b. Telephoto.
c. Wide angle.
d. Fisheye.

54. (237) If you needed to produce a larger image size on your film and you could not move the camera, you should use

a. a wide angle lens.
b. a telephoto lens.
c. the lens that is "normal."
d. the 180° fisheye lens.

55. (238) The impression of depth in a 2-dimensional picture is known as

a. distinction.
b. depth of field.
c. perspective.
d. relationship.

56. (239) If you must increase the depth of field, what action should you take?

a. Use a long focal length lens.
b. Move closer to the subject.
c. Close down to a smaller aperture.
d. Use the critical aperture.

57. (239) The distance from the lens to the nearest plane in focus is called the

a. acceptable focus length.
b. hyperfocal distance.
c. critical focal point.
d. depth of focus.

58. (239) You need to take a picture of five objects in a straight line that runs generally away from you, what object should you focus on to ensure adequate depth of field?

a. Any of the objects.
b. The first object.
c. The second object.
d. The last object.

59. (240) The zone or area that the field can be moved back and forth in without being unacceptably sharp is called the

a. depth of field.
b. focal length.
c. 2/5th zone.
d. depth of focus.

60. (241) How many f/stops is the critical aperture from the widest aperture?

a. Two.
b. Four.
c. Five.
d. Eight.

61. (242) Optical flare and mechanical flare are caused by

a. the coating on the lens.
b. being too close to your subject.
c. simple one-element lenses.
d. reflections in or near the lens.

62. (243) Which one of the following types of filters is available in the widest variety of colors?

a. Glass.
b. Gelatin.
c. Plastic.
d. Tiffen.

63. (243) Which type of filter is the most durable?

a. Plastic.
b. Glass.
c. Tiffen.
d. Gelatin.

64. (244) If you used orthochromatic film with a red filter, what effect would this have on the negative?

a. Red objects would be dark and green objects would be light.
b. Blue, green, and red objects would completely expose the negative.
c. Blue objects would be light and red objects would be dark.
d. Red, green, and blue objects would not make an exposure.

65. (244) Which of the following combinations could you use in place of a red filter?

a. Yellow and cyan.
b. Magenta and green.
c. Yellow and magenta.
d. Blue and magenta.

66. (245) If you had a basic exposure of f/8 at 1/100 and were using a filter with a factor of 2, what is your new shutter speed?

a. 1/200.
b. 1/150.
c. 1/50.
d. 1/25.

67. (245) When you use a filter with a filter factor of 4 and your basic exposure was f/16 at 1/100, what is your new exposure?

a. f/8 at 1/250.
b. f/8 at 1/50.
c. f/16 at 1/200.
d. f/16 at 1/25.

68. (246) Orthochromatic film cannot be used to achieve orthochromatic rendition because the film is

a. too slow.
b. limited in sensitivity.
c. too high in contrast.
d. too low in contrast.

69. 246) What color of correction filter can you use to achieve orthochromatic rendition of an outdoor scene when you are using panchromatic film?

a. Medium yellow.
b. Light blue.
c. Orange.
d. Red.

70. (247) If you want a red flower to appear darker than the green leaves in the final print, what color of contrast filter should you use with panchromatic film?

a. Green.
b. Red.
c. Blue.
d. Yellow.

71. (247) A red filter would help produce acceptable results for all of the following except

a. fake night shots.
b. portraits of women.
c. scenics where you want to darken the sky.
d. architecture shots of light-tone buildings.

72. (248) If the light is so bright that you cannot close down enough or use a fast enough shutter to prevent over-exposure, what kind of filter should you use?

a. Neutral density.
b. Polarizing.
c. Correction.
d. Light balancing.

73. (248) If you needed to close down one stop and couldn't because of the limitations of your lens, you should choose a neutral density filter with a factor of

a. 2.
b. 4.
c. 7.7.
d. 20.

74. (249) What type of filter can you use to reduce glare from water, windows, and glossy prints?

a. Polarizing.
b. Correction.
c. Contrast.
d. Gelatin.

75. (250) What color of light is in excess in a hazy lighting condition?

a. Red.
b. Orange.
c. Yellow.
d. Blue.

MAIL TO: ECI, GUNTER AFS AL 36118-5643

STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 10 USC 8012. PRINCIPAL PURPOSE: To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with ECI course package, and used by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's inquiry. Failure to provide all information would result in slower action or inability to provide assistance to the student.

I CORRECTED OR LATEST ENROLLMENT DATA

1. THIS REQUEST CONCERNS COURSE (1-6)
2. TODAY'S DATE
3. ENROLLMENT DATE
4. AUTOVON NUMBER
5. SOCIAL SECURITY NUMBER (7-15)
6. GRADE/RANK
7. NAME (First initial, second initial, last name) (17) – (18) – (19-32)
8. ADDRESS (33-53) (54-75)

OJT ENROLLEES: Address of unit training office with zip code.

ALL OTHERS: Current mailing address with zip code.

9. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE
10. TEST CONTROL OFFICE ZIP CODE/SHRED (33-39)

II REQUEST FOR MATERIALS, RECORDS, OR SERVICE

X	*Place an "X" through number in box to left of service requested.*
1	Request address change as indicated in Section I, Block 8.
2	Request Test Control Office change as indicated in Section I, Block 10.
3	Request name change/correction. *(Provide Old or Incorrect data here)*
4	Request Grade/Rank change/correction.
5	Correct SSAN. *(List incorrect SSAN here.)* *(Correct SSAN should be shown in Section I.)*
6	Extend course completion date. *(Justify in "Remarks")*
7	Request enrollment cancellation. *(Justify in "Remarks")*
8	Send VRE answer sheets for Vol(s): 1 2 3 4 5 6 7 8 9 10 Originals were: ☐ Not received ☐ Lost ☐ Misused
9	Send course materials. *(Specify in "Remarks")* ☐ Not received ☐ Lost ☐ Damaged
10	Course exam not yet received. Final VRE submitted for grading on ____________ (date).
11	Results for VRE Vol(s) 1 2 3 4 5 6 7 8 9 10 not yet received. Answer sheet(s) submitted ____________ (date).
12	Results for CE not yet received. Answer sheet submitted to ECI on ____________ (date).
13	Previous inquiry (☐ ECI Fm 17, ☐ ltr, ☐ msg) sent to ECI on ____________ (date).
14	Give instructional assistance as requested on reverse.
15	Other *(Explain fully in "Remarks")*

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REMARKS *(Continue on reverse)*

OJT STUDENTS must have their OJT Administrator certify this record.

ALL OTHER STUDENTS may certify their own requests.

I certify that the information on this form is accurate and that this request cannot be answered at this station.

SIGNATURE

ECI FORM 17 DEC 84 PREVIOUS EDITION WILL BE USED.

BEST COPY AVAILABLE

REQUEST FOR INSTRUCTOR ASSISTANCE

NOTE: Questions or comments relating to the accuracy or currency of subject matter should be forwarded directly to preparing agency. For an immediate response to these questions, call or write the course author directly, using the AUTOVON number or address in the preface of each volume. All other inquiries concerning the course should be forwarded to ECI.

VRE ITEM QUESTIONED:

COURSE NO ____________

VOLUME NO ____________

VRE FORM NO ____________

VRE ITEM NO ____________

ANSWER YOU CHOSE ____________ *(Letter)*

HAS VRE ANSWER SHEET BEEN SUBMITTED FOR GRADING?

☐ YES ☐ NO

REFERENCE

(Textual reference for the answer I chose can be found as shown below.)

IN VOLUME NO ____________

ON PAGE NO ____________

IN ☐ LEFT ☐ RIGHT COLUMN

LINES ________ THROUGH ________

MY QUESTION IS:

REMARKS

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. Course workbooks have a Form 17 printed on the last page.

ECI FORM 17, DEC 84 *(Reverse)*

23132 03 7904

CDC 23132

APPRENTICE STILL PHOTOGRAPHIC SPECIALIST

(AFSC 23132)

Volume 3

Photographic Camera Assignments

Extension Course Institute

Air Training Command

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THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

Preface

THIS THIRD VOLUME of CDC 23132, *Apprentice Still Photographic Specialist,* emphasizes the application of general camera assignments. Since photography is an art rather than an operational career field, we don't have cut and dried rules for camera assignments. Therefore, most of this volume deals with concepts and ideas that are abstract.

Chapter 1 explains photographic composition. Many shots are spoiled by poor composition or a total lack of it. In this chapter, we offer ideas and concepts of composition which you may use. We discuss creative techniques as well as basic concepts and corrective procedures. Chapter 2 deals with general assignments. In this chapter we cover the planning of missions, industrial, and investigative assignments. We also give you a brief introduction to photojournalistic techniques. It is not our intent to lay down rigid rules on how to accomplish these assignments, but to point out certain techniques that you may find useful. Chapter 3 covers the types of photos you will have to produce in the studio. These include portraits, passports, identification, and special assignment photographs. In Chapter 4 we discuss the fundamentals of copy and reproduction photography. We cover types of originals, techniques, processing, and finishing of copy materials. As in Chapters 2 and 3, Chapter 4 also covers operator's maintenance.

If you have questions on the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to the 3430th TCHTG/TTMZS, Lowry AFB CO 80230. Questions requiring immediate resolution may be directed to the course author, AUTOVON 926-4142, between 0700 and 1530 hours (MST), Monday through Friday. NOTE: Do not use the suggestion program to submit corrections for typographical or other errors.

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to Career Development, Behavioral Objective Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If this agent can't answer your questions, send them to ECI, Gunter AFS AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 12 hours (4 points).

Material in this volume is technically accurate, adequate, and current as of January 1979.

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NOTE: In this volume, the subject matter is developed by a series of Learning Objectives. Each of these carries a 3-digit number and is in boldface type. Each sets a learning goal for you. The text that follows the objectives gives you the information you need to reach that goal. The exercises following the information give you a check on your achievement. When you complete them, see if your answers match those in the back of this volume. If your response to an exercise is incorrect, review the objective and its text.

Principles of Photographic Composition

COMPOSITION IN photography is a process of combining or relating all of the elements of a scene into a particular position or relationship within the space of a photograph. When all parts of the scene are combined to form one harmonious whole, the result is a photograph having good composition.

Learning the art of good composition is similar in many respects to learning any other skill or profession. First, learn the rudiments, correctly. Then through much practice and attention, develop the talent to a high state of perfection. In the early stages of learning we depend almost exclusively on what we can see and hear, imitating what has been done before.

Much can be learned about composition by studying various works of art and collections of good photographs. Each one offers an example of how to present a subject in an effective and interesting manner. By the simple process of attempting to duplicate some of these photographs, many of the basic elements of composition can be learned.

1-1. Applying Basic Elements

You should have an idea of what you want as a final product before you move in to make the shot. All subject elements should be properly arranged with consideration given to the lighting and the appearance of the various tones, textures, and shapes (fig. 1-1.) Many distracting elements can be eliminated by applying the principles of good composition. It will be very difficult, if not impossible, to correct mistakes caused by the wrong camera position or poor scene arrangement at a later point in the photographic process. You should do your cropping and composing before you trip the shutter.

400. Specify principles and techniques which are used to achieve effective composition.

Although good composition is something that each photographer must learn to feel for himself, you can consistently produce good quality photographs by using basic guidelines for composing your picture.

Point of Interest. Every photograph should have one definite point of interest. If the viewer is distracted by a jumble of elements, the main subject of the photograph will not stand out. (See fig. 1-2.) This makes it difficult to determine the purpose of the photograph. The point of interest may be a single object or consist of several elements. The key is that all parts should be arranged so that the viewer's attention is drawn directly to the subject. (See fig. 1-3.)

Simplicity. One sure way to emphasize your subject is to simplify by minimizing the number of elements presented in the picture. As we have said before, the camera lens sees everything that exists in front of it. Therefore, adjust your camera angle and camera-to-subject distance until all but the essentials have been eliminated from your picture. As a start toward simplification: (1) move closer to your subject, (2) choose a plain background, and (3) let the lighting emphasize your subject. Compare figures 1-4 and 1-5 to see the improvement that simplicity can make.

Horizon Line. Most outdoor, and many indoor, photographs have a real or imaginary horizon line—the line where the sky seems to meet the earth or where the foreground or middle ground meets the background. The proper placement of the horizon line will help you arrange the background, the foreground, and the main subject areas of your picture. You should try to keep the horizon line level. (See fig. 1-6.) Next, try to remember never to place the horizon line in the direct center of the photograph. If you do, you divide the photograph into two equal parts and produce a dull and uninteresting picture. (See fig. 1-7.) Try to position the horizon line above or below the exact center of the photograph. A high horizon line gives the appearance of depth and distance. (See fig. 1-8.) A low horizon line creates an appearance of increased height. (See fig. 1-9.)

The Golden Mean. The Greek sculptors and the great painters and architects of the Middle Ages used

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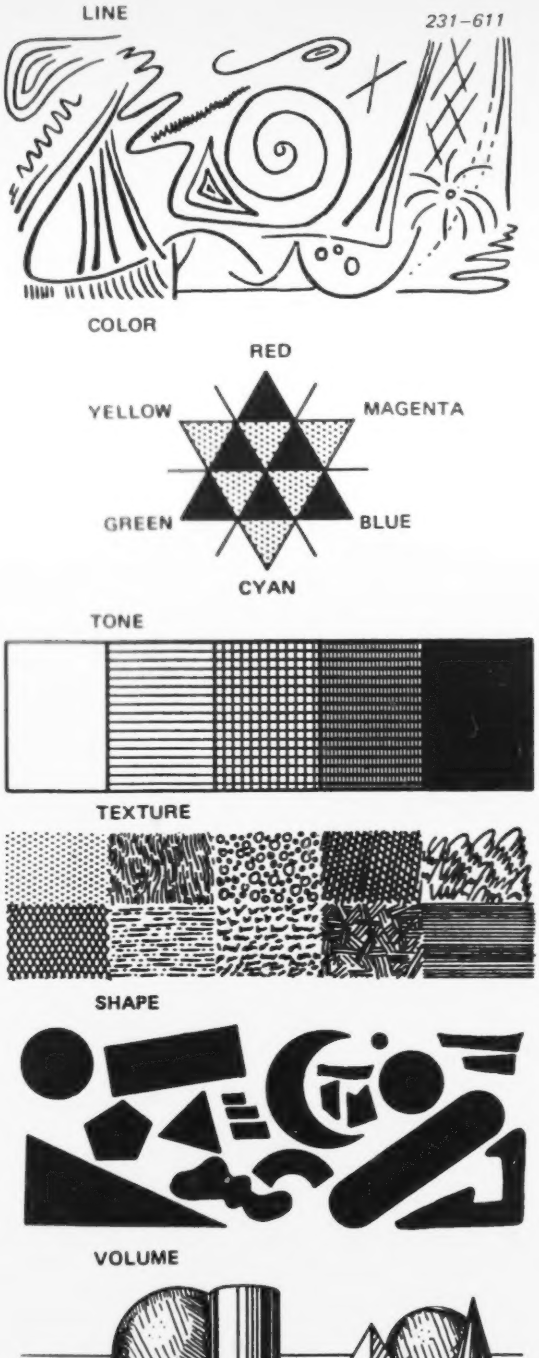


Figure 1-1. Compositional elements.

what has been called "The Golden Mean" (fig. 1-10) to help them establish correct proportion and placement of their subjects. We can apply this principle in photography by dividing our rectangular picture area into thirds, both horizontally and vertically. Then we can place our horizon line on, or close to, one of the 1/3 lines while placing our subject on one of the four intersecting points. (See fig. 1-11.) Some photographers actually draw lines on their ground glass to apply this principle.

Leading Lines. One of the most common techniques in directing attention toward the point of interest is the use of leading lines, shapes, or patterns. A leading line may be any object, or any series of objects, which tends to direct the observer's eyes toward the point of interest. It may be a road, a fence, a row of trees, a shoreline, or even a patch of light or dark tone in the scene. An ideal leading line is one that starts near a bottom corner of the scene and continues unbroken until it reaches the point of interest. (See fig. 1-12.) It should end at this point, otherwise the observer's attention will be carried beyond the main object in the picture.

Framing. Another very effective method of confining attention to the point of interest is by framing it with such objects as trees, columns, a doorway, an arch, or a window. For example, looking across a broad expanse of land or water at a house can give an observer a rather dull, uninteresting view; while, by moving back a few feet and framing the same house between clumps of trees may improve the composition. (See fig. 1-13 to see how framing can be used.)

Handling of Action. A photograph depicting action or movement of any kind tends to lead the viewer's eyes in the direction of the action. Consequently, your composition is strengthened if the action leads into the photograph. Action shots require correct shutter speed selection and careful camera handling. A fast shutter speed creates a stop-action effect, while a slow shutter speed makes the subject blurry. (See figs. 1-14 and 1-15.) If the camera is held still, the subject may appear blurred while the background remains sharp. If the camera follows the action (panning), then the subject will appear sharp and the background will appear blurred. Panning can be used to stop rapidly moving subjects. (See fig. 1-16.)

Balance. In a well-balanced picture, the position of the various elements of the photograph gives harmony to the whole setting. Your problem with balance is to arrange the various objects into a specific design. There are two types of balance: formal (symmetric) and informal (asymmetric).

Formal balance is achieved by arranging elements having similar size or shape on either side of an imaginary central dividing line in order to produce a balanced relationship within the composition. (See fig. 1-17.) Generally speaking, this type of balance should be avoided, since it usually fails to stimulate the viewer's interest. For example, although a single subject placed in the exact center of the photograph provides the simplest kind of balance, this should be

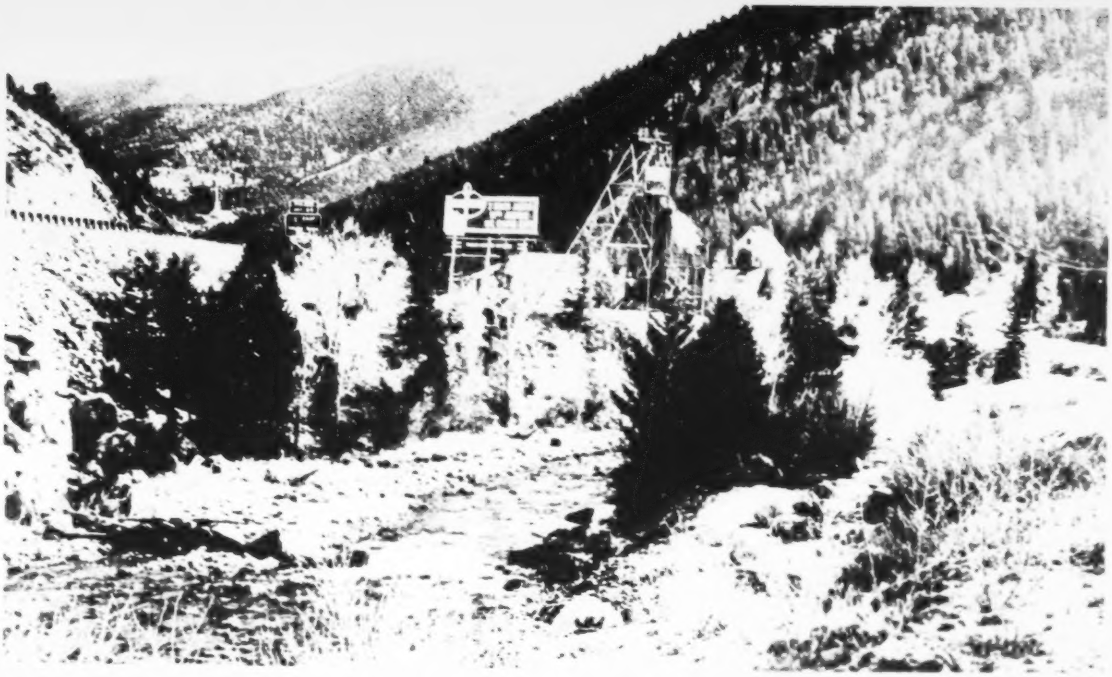


Figure 1-2. A scene having no point of interest.

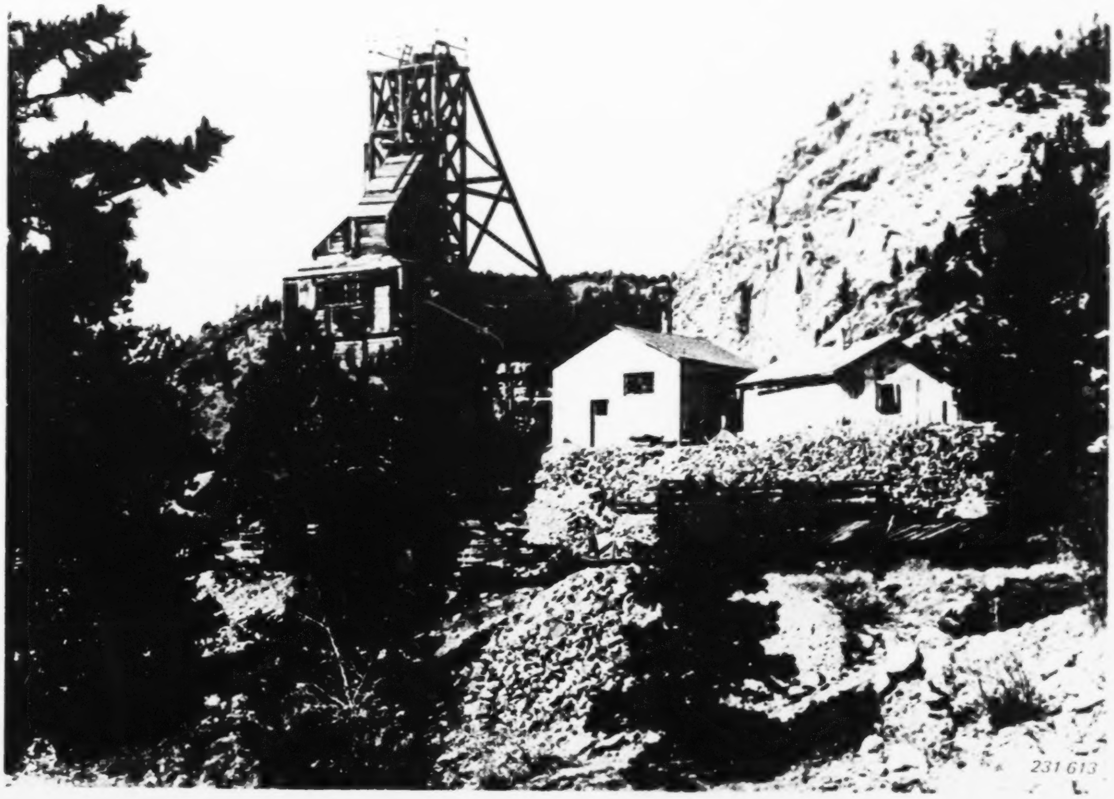
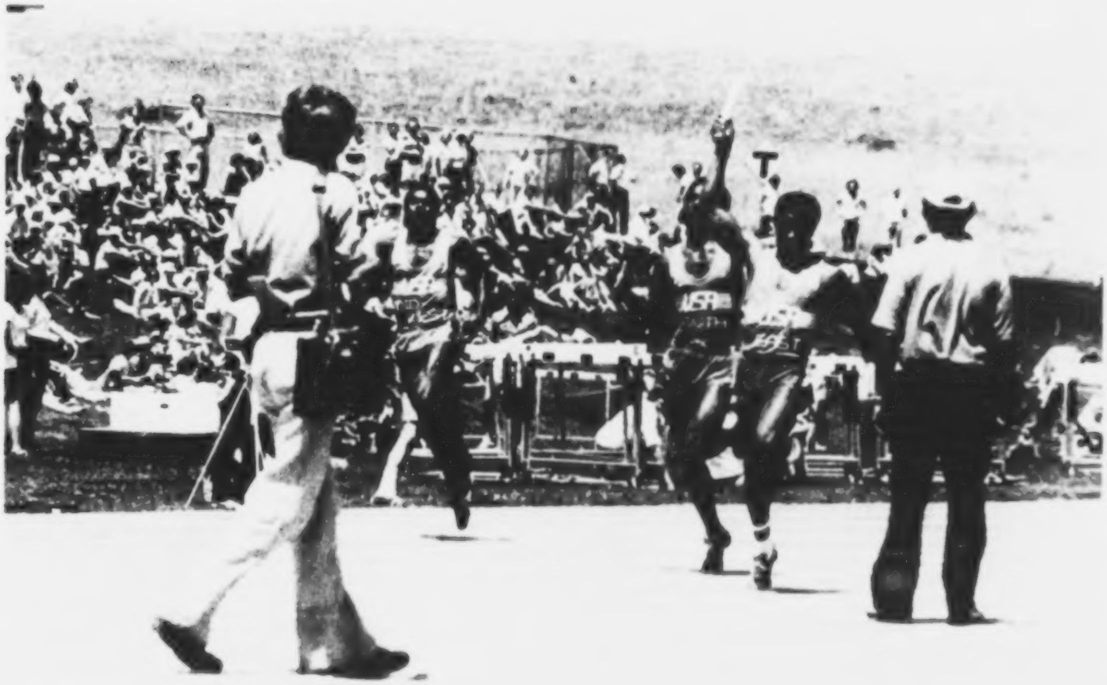


Figure 1-3. A scene having a definite point of interest.


USA
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USA
EAST

Figure 1-4. A picture lacking simplicity.

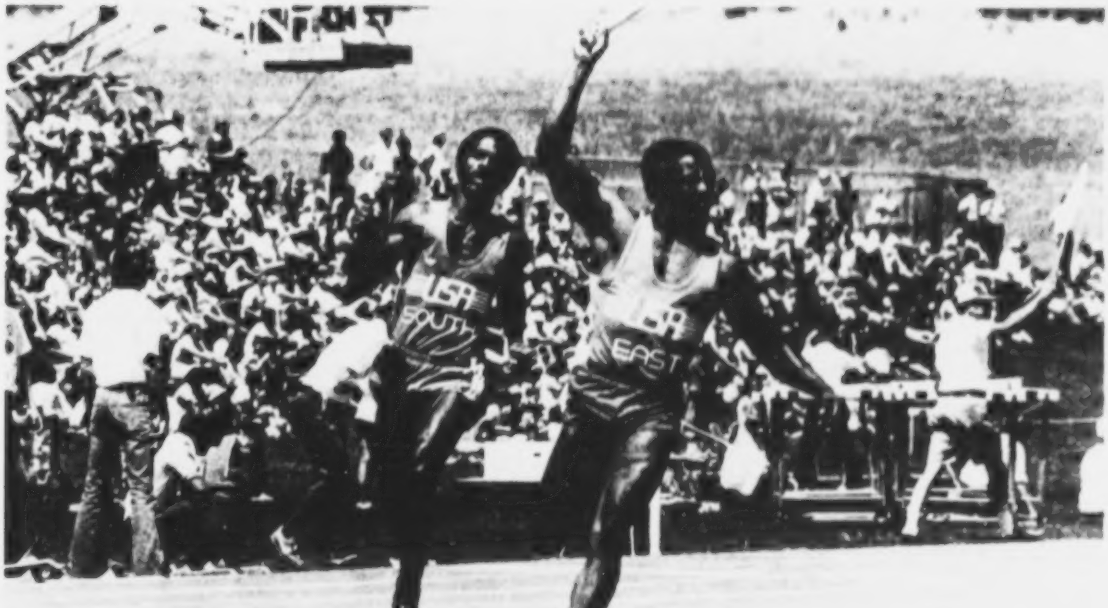
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Figure 1-5. A picture showing simplicity.

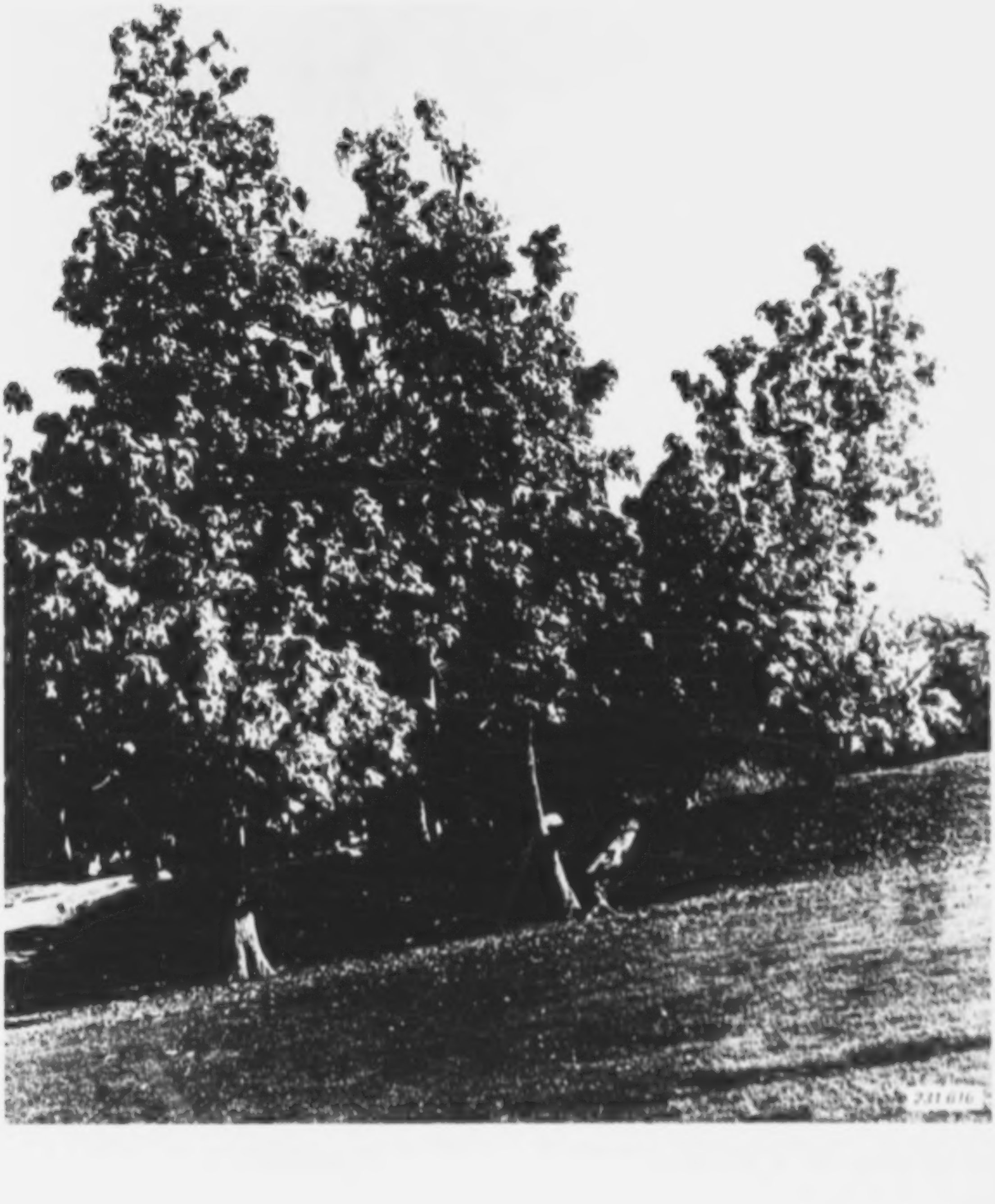

Figure 1-6. A crooked horizon line leads to awkward composition.

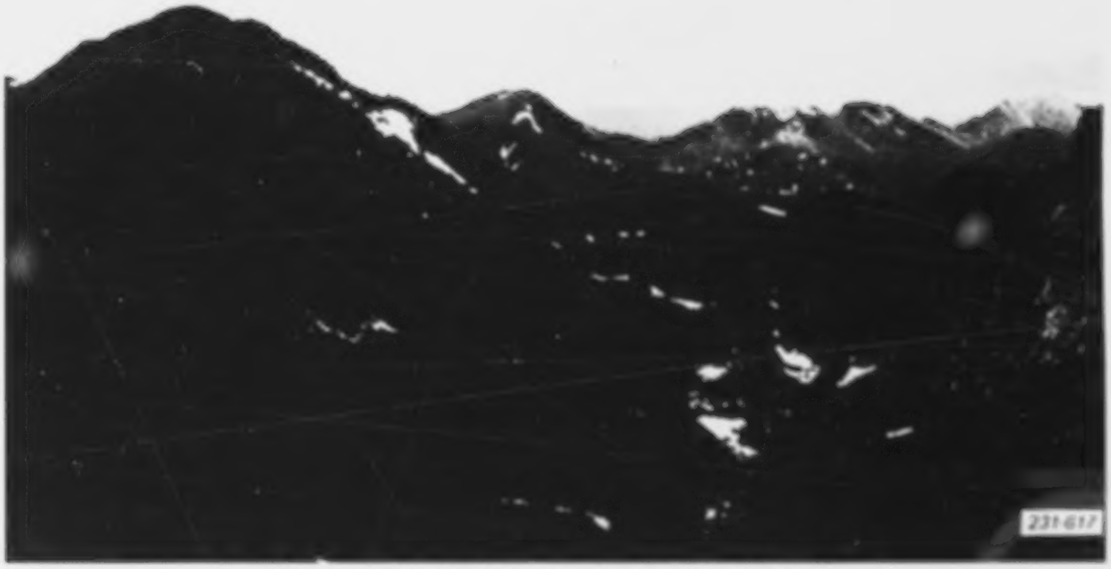

Figure 1-7. A horizon line that divides the subject in half leads to dull pictures.

avoided for the reason just given. We can sum up formal balance by saying that it is dividing a composition into equal parts, with none of the parts being dominant. Although this is sometimes pleasing to the eye, it quickly becomes monotonous through overuse.

In contrast, informal balance involves a pleasing relationship between dissimilar forms and/or subject arrangements. For example, a smaller area or object can balance a much larger one if the smaller area contains a form or subject that attracts the viewer's attention more than anything contained in the larger area. You can cause attention to be focused on the smaller area by varying the color, texture, tone, shape, or activity in the two areas. (See fig. 1-18.)

Format. Format determines the shape of the photograph. It may be horizontal, vertical, or square. Format is important, and your selection will influence both the appearance and the meaning of the photograph. Here are a few suggestions concerning the choice of format. If the shape of your subject indicates a given format, use that format. For example, tall objects usually fit a vertical format, whereas wide objects require a horizontal format. A square format is, however, rarely used. Remember, you can achieve a different format easily and quickly by turning your camera or changing your easel during printing.

The Third Dimension. Perspective is defined as the rendering of a three-dimensional subject (height,

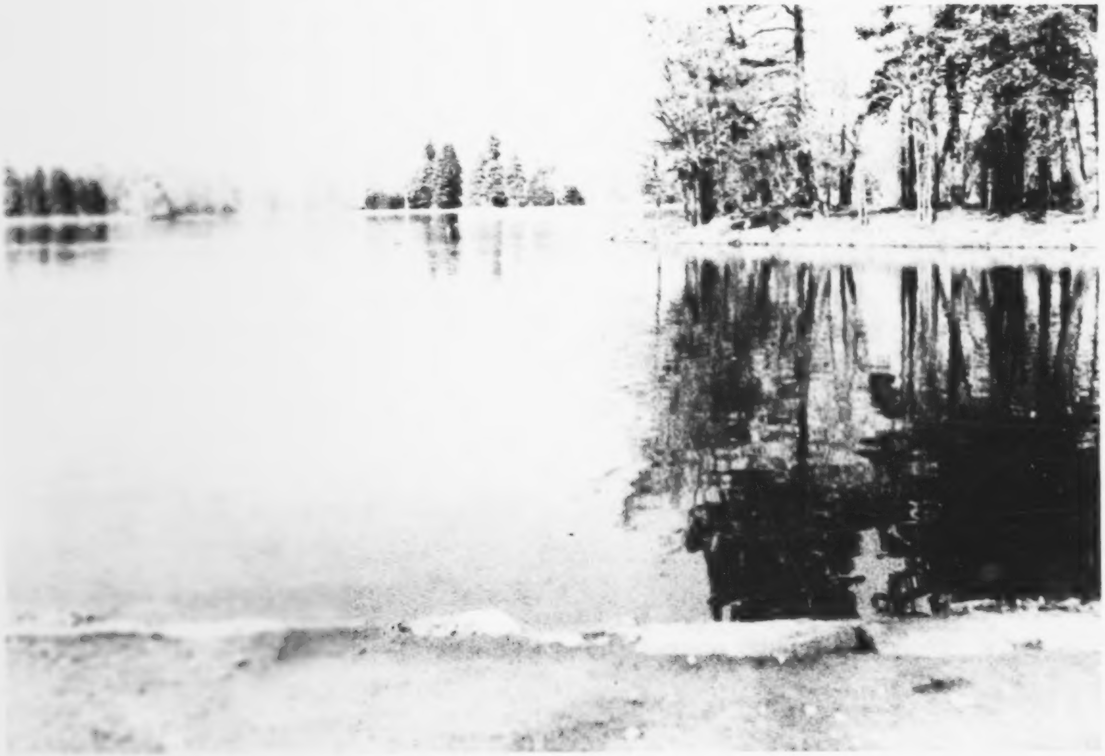

Figure 1-8. A high horizon line emphasizes depth.

width, and depth) on a two-dimensional surface (height and width). This problem faces both painters and photographers. The main challenge is to retain a feeling of illusion of depth. There are four means of expressing depth in composition. These are line, figure, light, and haze effects. (See fig. 1-19.) A leading line going into the picture (road, river, or a fence, etc.) can create a feeling of depth. The relative size of the subject matter can also help to create the illusion of depth. For example, objects in the background look smaller and farther away even though they are of the same size. This is so because we know that the reduction in image size is caused by an increase in distance. Lighting can also be used to help create the appearance of depth. Long shadows cast into the picture promote a feeling of distance. Finally, a diminishing sharpness, caused by haze, can give the feeling that the background is far away.

Subject Size. Your ability to decide how much of the subject should be included in any photograph is very important. For example, you can photograph just the subject itself or only part of the subject. You can make the subject small and include much of the surrounding area. Generally, however, you cannot go wrong if you make your subject as large as possible. When you check the viewfinder or the ground glass, you may find that much of the area surrounding the subject is not an important part of the picture and can be eliminated. In fact, eliminate everything that is not absolutely essential to the purpose of the photograph. This applies to parts of the subject itself. If a picture is correctly composed, you cannot add or subtract anything without adversely affecting the quality of the photograph.

Background Control. Many photographers overlook the background during composition of the

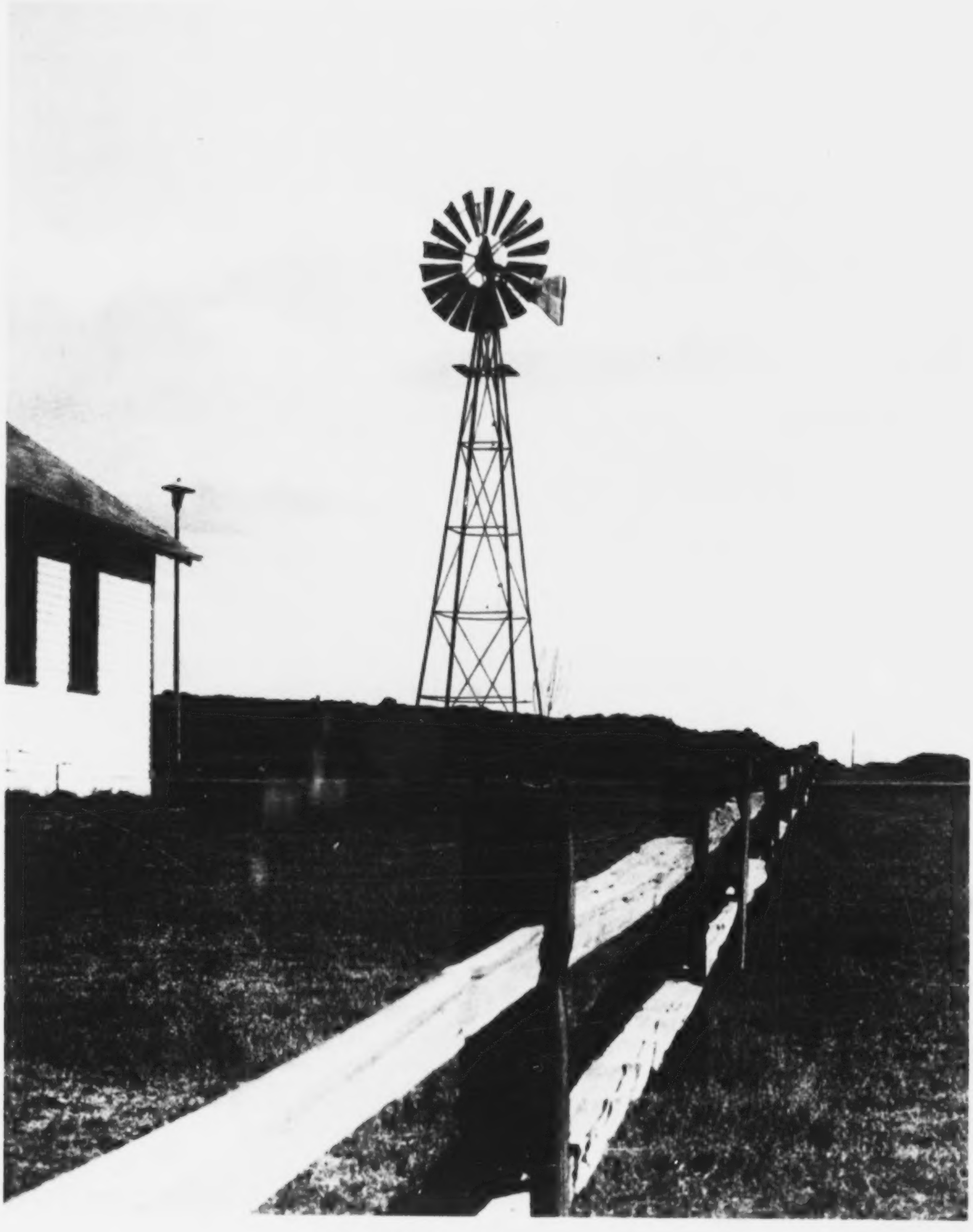

Figure 1-9. A low horizon line emphasizes height.

photograph. When the finished print is examined, however, the viewer will quickly realize that the background should have been taken into consideration. This is especially true if the background contains elements that distract from the main subject. Through neglect, the background may destroy the quality of your subject arrangement. Therefore, look beyond the subject and check the background area. In some instances the background will be inappropriate, cluttered, or disorganized. If this is the case, you will have to exercise background control. You can do this in several ways. For instance, you can (1) move the subject to another location, (2) change the camera position, (3) change the camera angle, (4) remove the objectionable background from the composition, or (5) throw the background out of focus by using a large aperture (i.e., limited depth of field.)

Foreground Control. Like the background, the foreground is important. In most cases, the foreground should be in focus and be of sufficient depth to support the subject. Don't let foreground objects detract from the point of interest. As a rule, the foreground will contain the leading line. Consequently, a fuzzy, out of focus foreground will irritate the viewer and detract from the point of interest. Occasionally an out-of-focus foreground is used in portraiture where the foreground forms a frame for the subject's face.

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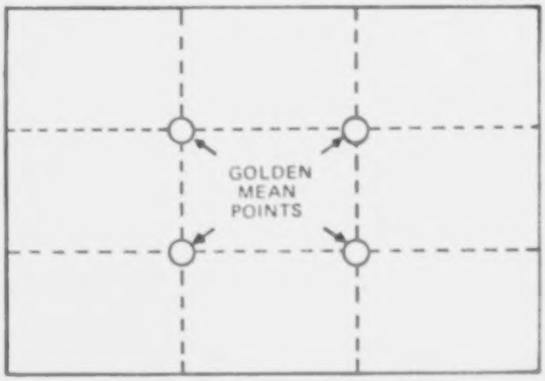

1–DIVIDE THE COMPOSITION INTO THIRDS
2–PLACE THE HORIZON ON OR CLOSE TO THE ONE–THIRD LINE
3–PLACE YOUR CENTER OF INTEREST AT ANY GOLDEN MEAN POINT

Figure 1-10. The "Golden Mean."

Tone Balance. In black-and-white photography, the subject's colors and those surrounding it are presented as various shades of gray in the final photograph. Remember, the shade of gray produced depends on how much light the subject is reflecting. It is important that tones, especially those close together, do not blend and obscure detail. This problem can be avoided by making a slight change in your camera position or by using a filter or supplementary lighting and controlling film contrast during processing.

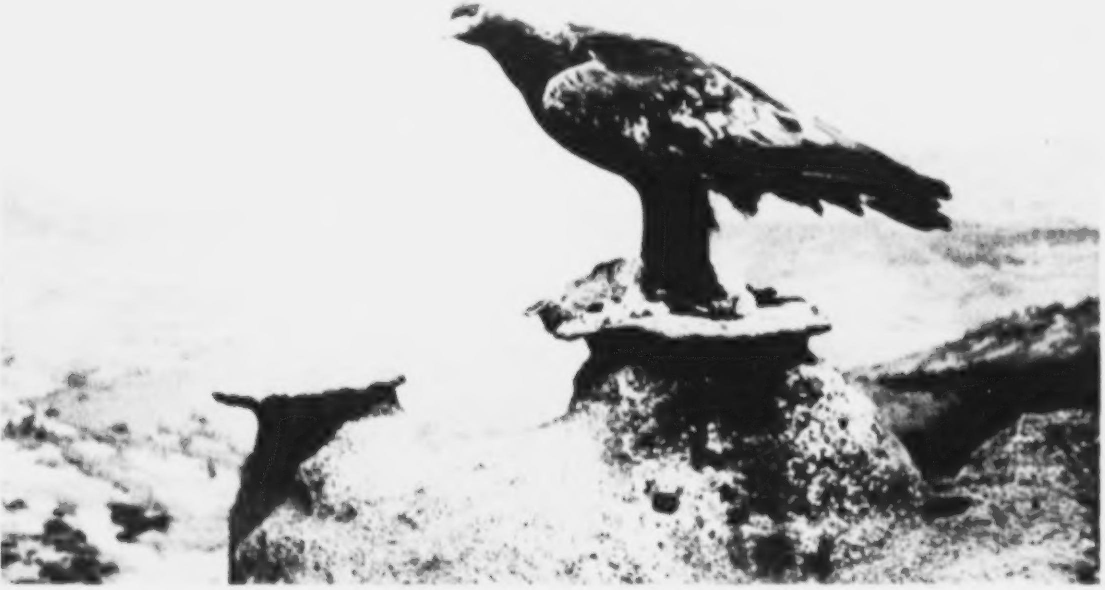

Figure 1-11. Placing subject according to the "Golden Mean."

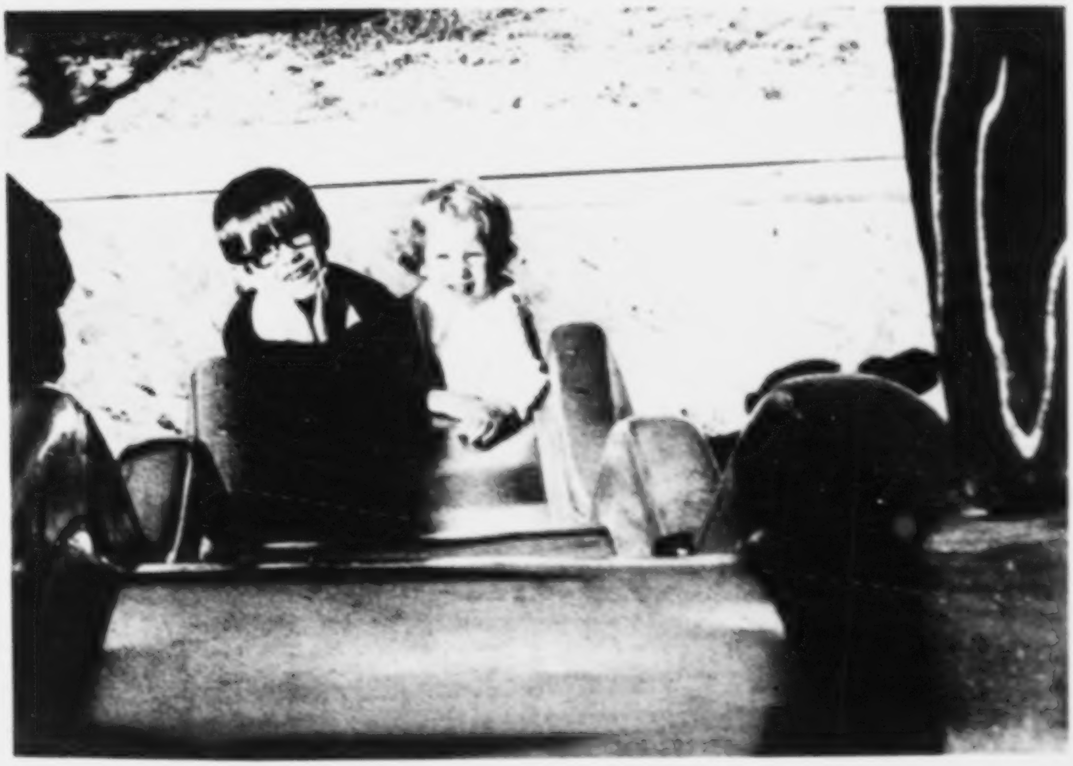

Figure 1-12. Use of leading line.

Exercises (400):

1. Why should every photograph have a clear point of interest?
2. What are three techniques that can be used to achieve simplicity in composition?
3. A high horizon line conveys what feeling?
4. What is the purpose of a leading line?
5. What will be the visual effect if you pan when photographing a moving object?
6. Haze in a scenic will help create what effect?
7. How are filters used in tone control?

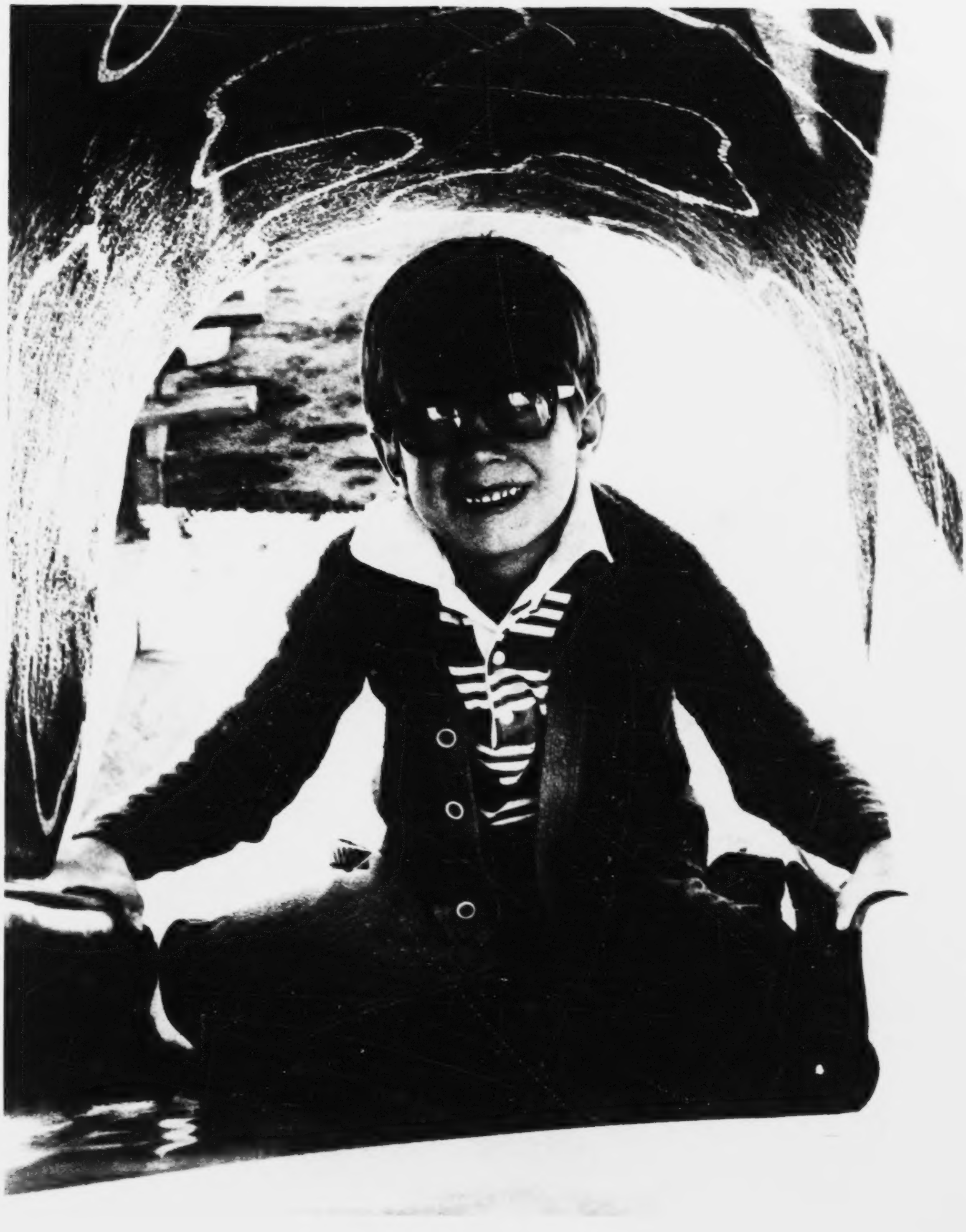

Figure 1-13. Framing the scene.

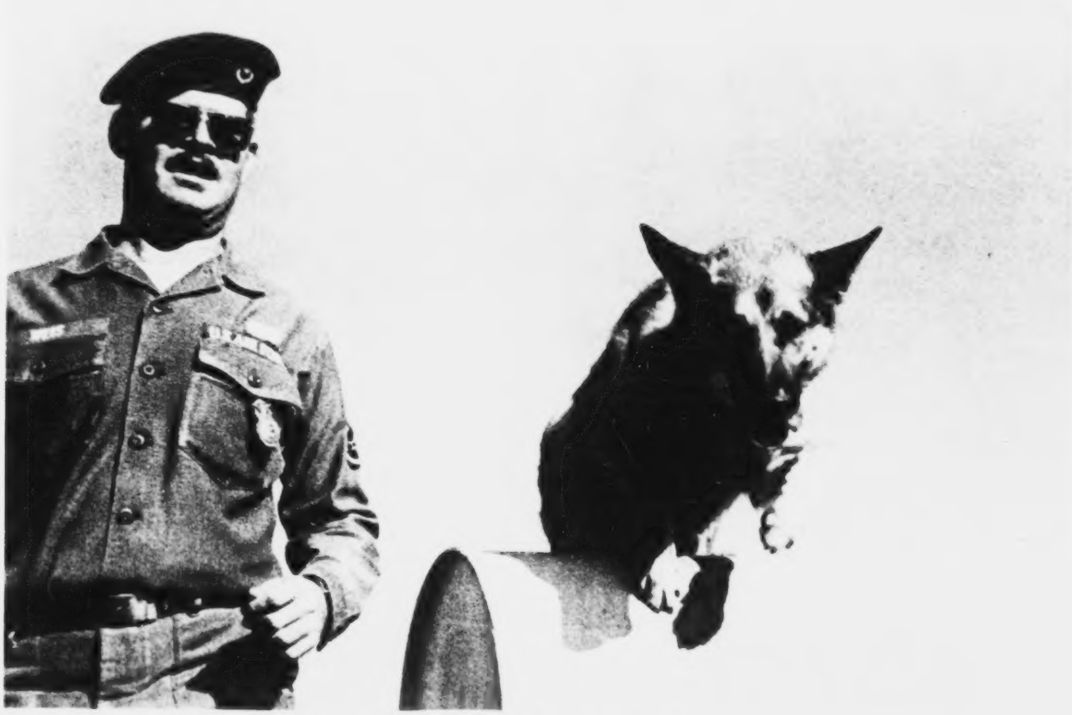

Figure 1-14. Use of fast shutter speed.

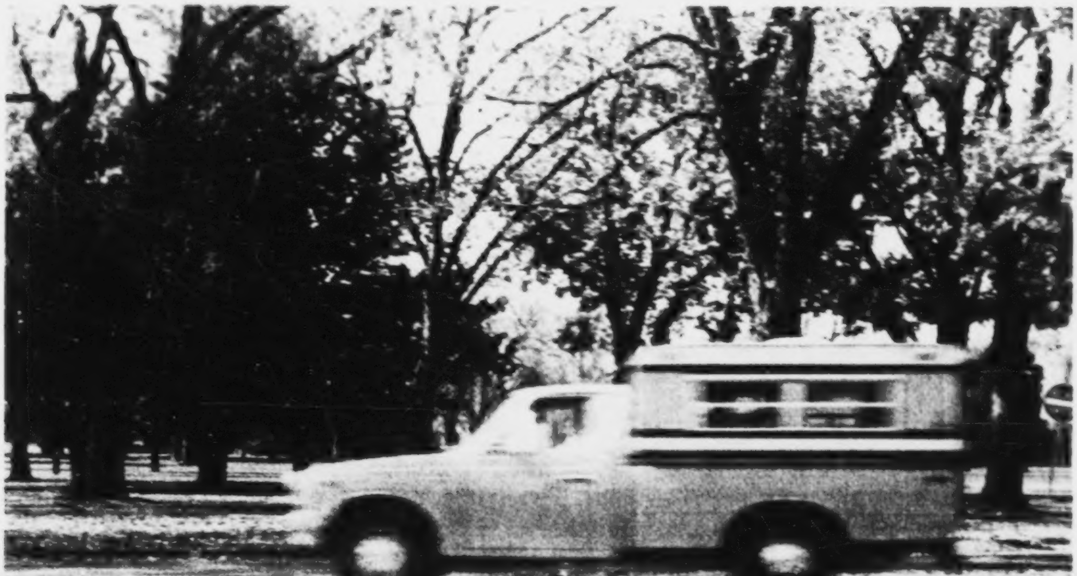

Figure 1-15. Use of slow shutter speed.

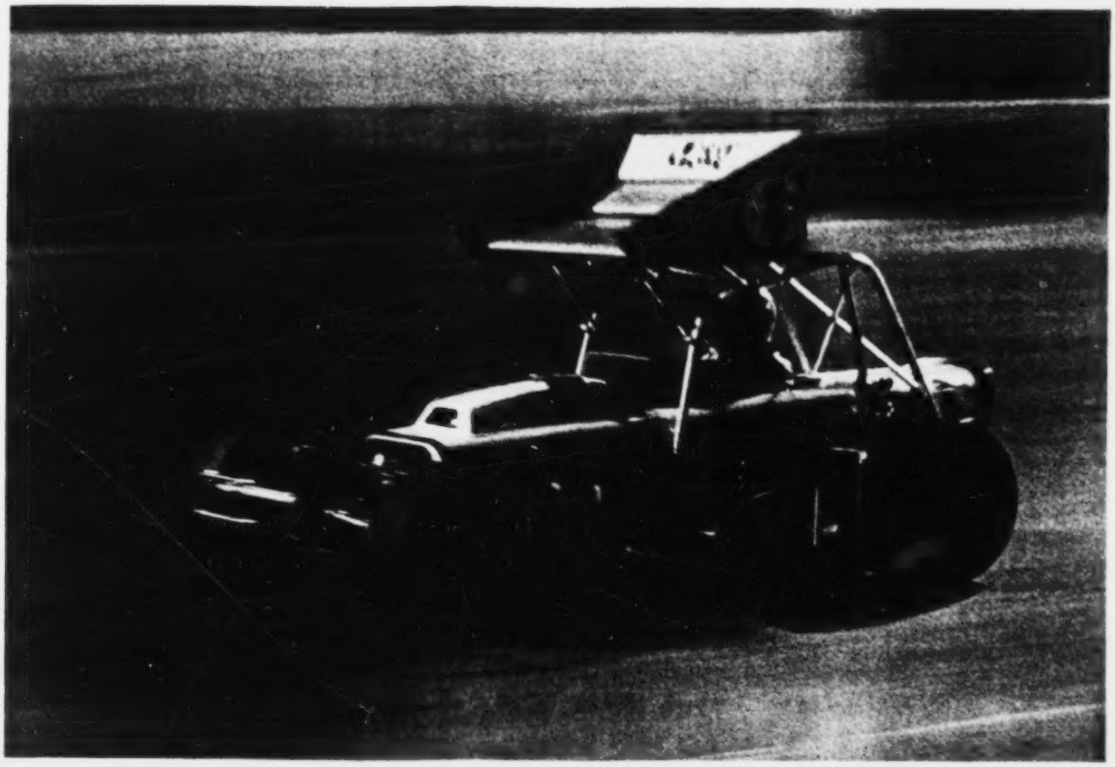

Figure 1-16. Use of panning.

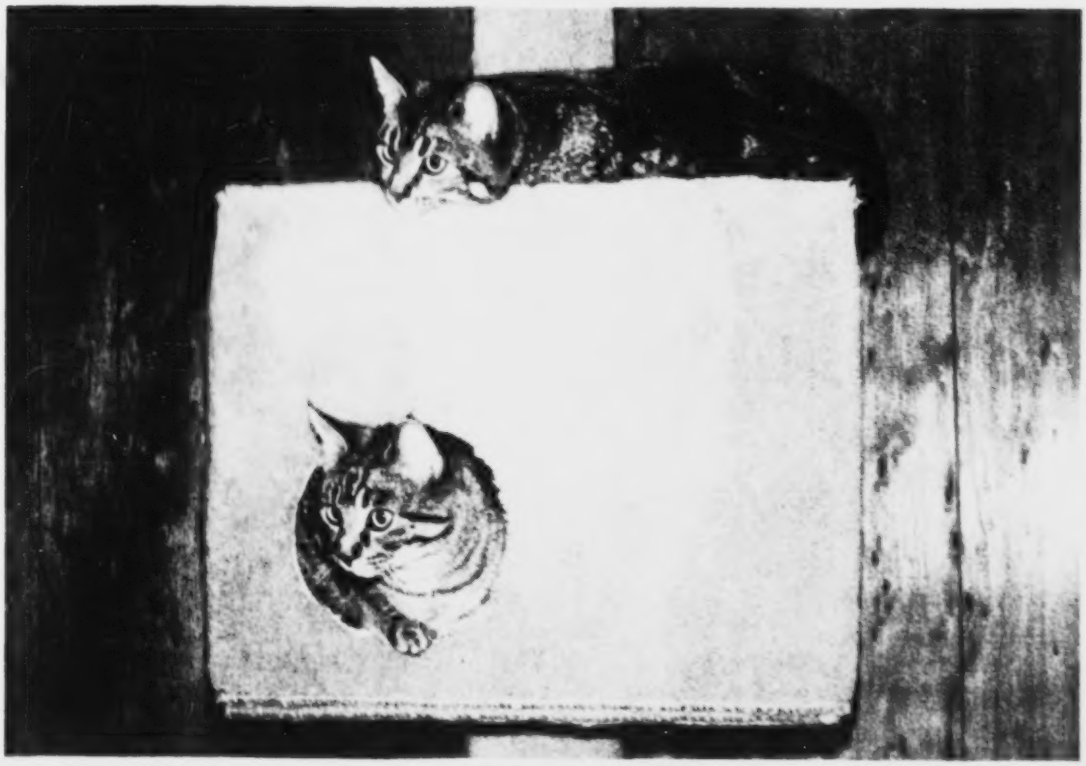

Figure 1-17. Using fromal balance.

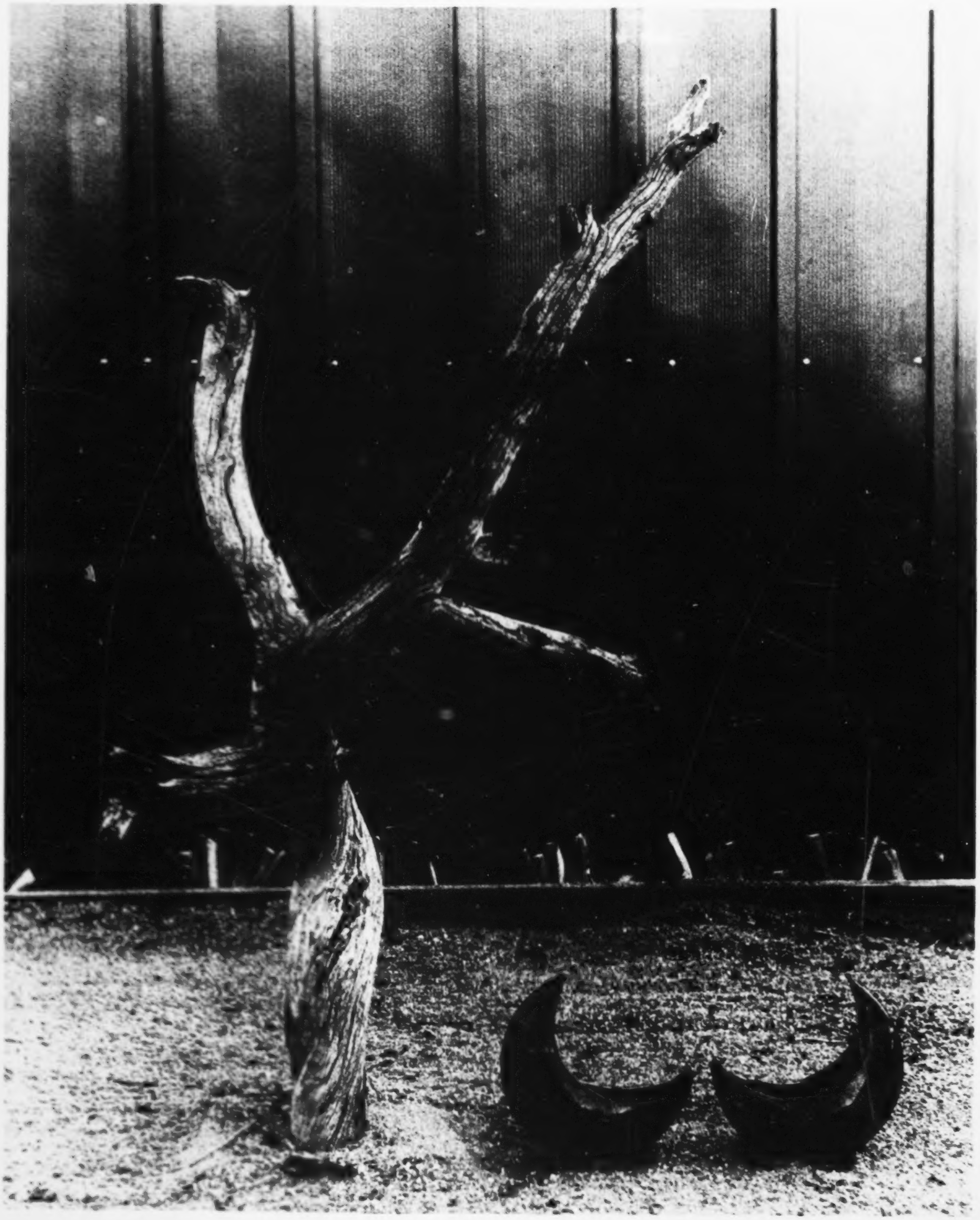

Figure 1-18. Using infromal balance.

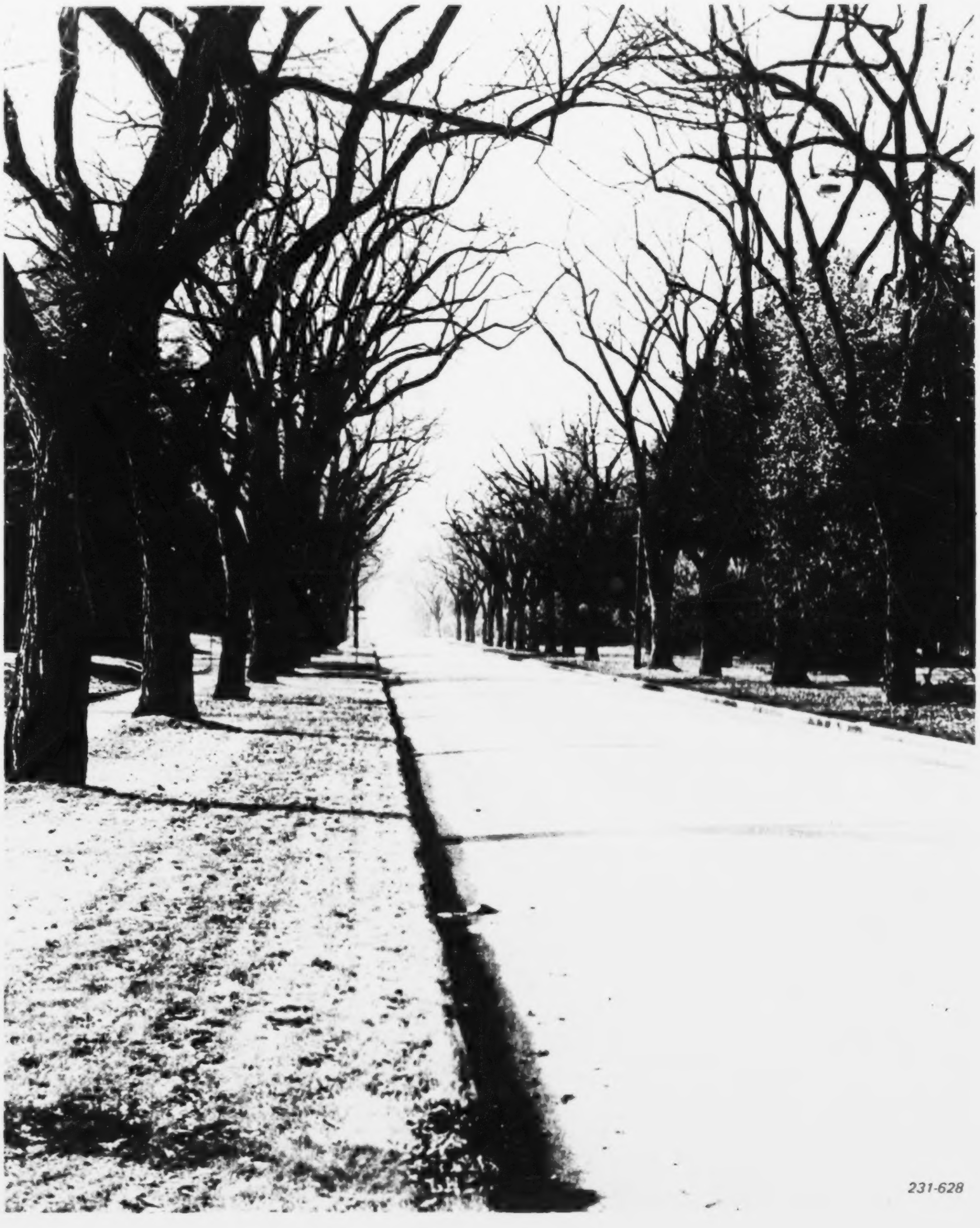

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Figure 1-19. Use of lines, light, figures, and haze gives feeling of depth.

1-2. Control Perspective

Remember in Volume 2 we said that perspective is the impression of depth when a three-dimensional scene is represented in a two-dimensional photograph. You have the means, while operating your camera, to control perspective. You can learn the art of showing objects or scenes in such a way to show them as they appear to your eye with respect to depth and distance. Since photography is two-dimensional, you have to create the illusion of three dimensions with photographic techniques. You must also maintain relationships between various elements of the scene so that they have a natural appearance. Perspective is, therefore, the most important of the corrective techniques that are used to get a pleasing picture.

401. Define "perspective" and cite two problems associated with it.

Whether a particular photograph looks natural or not often depends upon how we have been trained to see. For example, we accept the convergence of parallel lines in the horizontal. This commonly happens when we view the "narrowing" of railroad tracks as they recede in the distance. However, we do not accept the same phenomenon in the vertical. For example, if a photographer tilts his camera upwards in order to capture the top of the building, the walls of the building appear to converge toward the top and the building seems to be falling. The photographer, therefore, must be able to control the appearance of these parallel lines in his photograph to maintain a pleasing perspective.

Perspective is controlled by the camera position. Camera position controls the angle of view and the subject-to-camera distance. The choice of lens focal length, while not controlling perspective, can be helpful in maintaining the desired image size while allowing a change in camera position. In our tilting building example, the problem could have been avoided by using a suitable wide angle lens to give the necessary coverage or by moving far enough back so the available lens could give the coverage without the need for tilting.

Another type of problem is diminution. Objects in the background look smaller than those in the foreground even though they are of the same size. This, again, can be controlled to some degree by changing camera position and using the appropriate focal length to insure a useful image size.

Foreshortening is a form of distortion whereby background ~~foreground~~ objects appear to be disproportionally large. This often happens when a photographer moves in close with a ~~normal or wide angle~~ longer than normal focal length lens to maintain a large image as in portrait photography. To correct

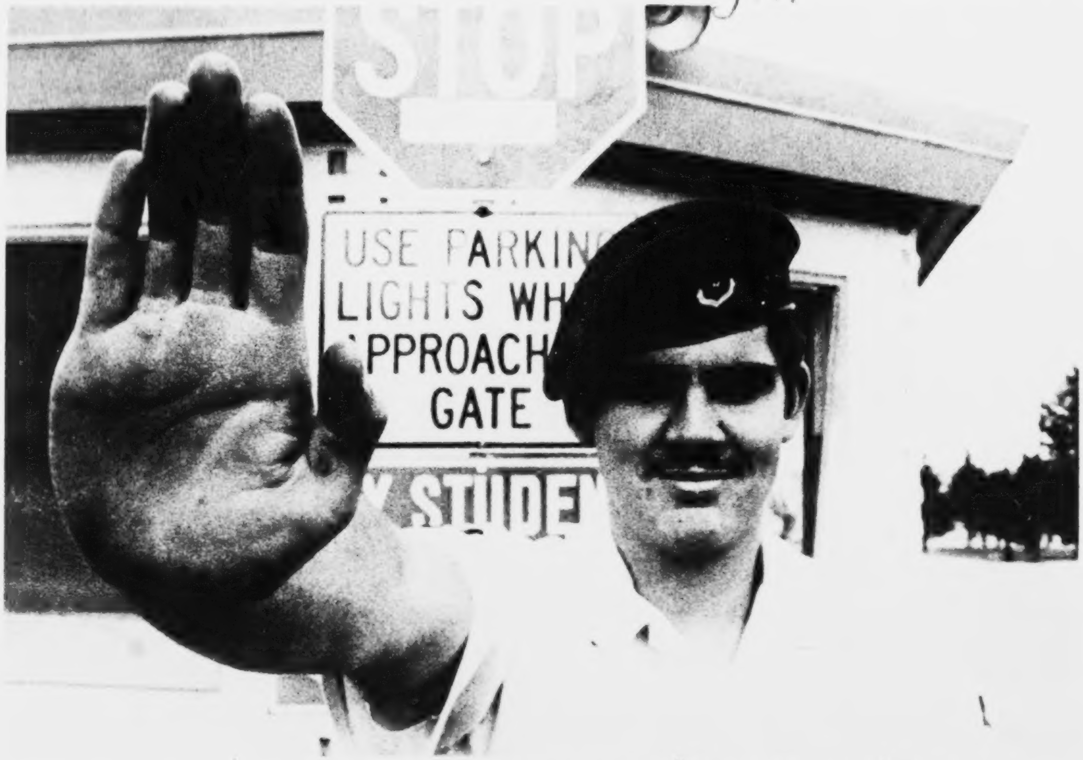

Figure 1-20. ~~Foreshortening~~. Diminution

this "problem" the photographer should step back and use a ~~longer~~ focal length lens. Shorter

It must be stressed that various types of "distortions" may be effective. For example, diminution gives a feeling of depth while foreshortening can be used to give a feeling of space. (See fig. 1-20.)

The key to perspective control is the camera position in relationship to the subject. The view camera, with its many adjustments, permits complete perspective control without the need to always "move" the camera from one position to another. Complete camera movement is provided by the set of swings, tilts, slides (shifts), the rising and falling front, and the rotating film back. These adjustments enable you to accomplish the following tasks:

a. You can control perspective and deliberately prevent, moderate, or exaggerate distortions.

b. In photographs taken at an angle, you can extend sharpness in depth.

c. You can also change the position of the image on the film without changing the position of the camera.

The view camera, therefore, is the choice for corrective procedures to achieve distortion free composition. Too many photographers, however, shy away from the view camera because of its bulk and many adjustments. The best way to be at ease with the camera is to practice with it before a job comes up. For example, you can arrange a simple still life in the studio. Using the camera straight on, with all the adjustments in neutral, focus on the subject. Take a picture with Polaroid film. Then use each of the adjustments one by one until you can clearly see the effect that each has on the result. Take a Polaroid photograph with each step. You can repeat this same process with an architectural shot. In this way, you will have a folder of pictures to refer to when you are getting ready for an assignment. Remember, knowledge gives you confidence.

NOTE: Limited corrective photography can be achieved with a 35-mm camera (e.g., Nikon) equipped with a perspective control lens. Such a lens can be adjusted out of the normal axis to control parallel lines, etc. This can be invaluable when you need color slides as an end product.

Exercises (401):

1. Define "diminution" and "foreshortening."

2. Explain how foreshortening can be prevented in portrait work.

3. Explain why a view camera is ideal for corrective photography.

4. Define "perspective."

1-3. Creative Techniques

To be creative means to be able to be productive; to achieve what was not there before; to assemble different elements in an effective and novel way. Every photographer should try to be as thoughtful as possible on every shot. In this section, we will discuss a few ideas you might consider trying when you wish to achieve better results.

It must be stressed that in the area of composition there are no firm "DO's" and "DON'Ts," just guides to help solve a visual problem. The best way to improve one's "eye" is through practice. Practice can take many forms. One way is to give yourself "self-assignments," like shooting a "little league" game in a refreshing way. Shooting, processing, and printing your work, followed by a thorough critique, is the best way to get better. In conjunction with this, the study of the work of leading photographers, painters, cinemaphotographers, and sculptors, who communicate a visual message, will provide much food for thought.

While the mastery of the various photographic skills is essential, one's attitude is the most vital ingredient. A willingness to learn, a desire to improve and demand upon oneself to accept nothing but one's best efforts, provide the power to go forward.

402. State how camera angle, subject matter parts, equipment, focus, and tone and contrast can be used in creative composition.

The following five topics are presented just to give you some ideas that you might consider when carrying out your assignments. Though we often stress equipment and particular techniques, it is the photographer and his visual insight of the subject in photographic terms that make the difference. YOU are the difference.

Camera Angles. Camera position is a most important choice in determining how a subject will appear. To achieve effective composition, it is best if you can take pictures from several camera angles. Do a 360° walk around the subject to get a clear idea of the possibilities. Then produce a variety of shots. Shoot up, down, left, right, front, back, three-quarters, etc. Each angle may show the subject in quite a different light. For example, shooting up makes the subject more imposing whereas shooting down will make the subject appear smaller and less important. The point being stressed is that if, for example, you take all your shots from the front at eye level your compositions will become monotonous. In figure 1-21, look at the effect that a variety of camera angles can have on how you see the subject.

A. FRONT

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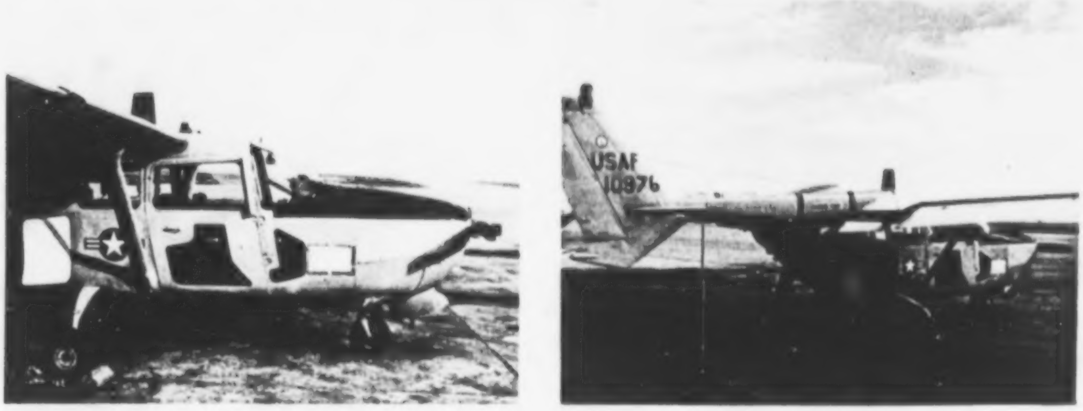
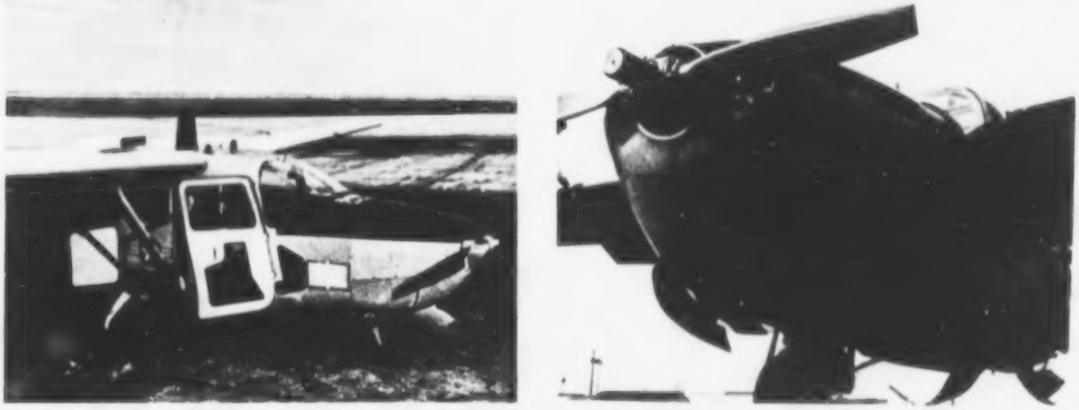


B. SIDE

C. BACK



D. TOP

E. SHOOTING UP

Figure 1-21. Camera angles.

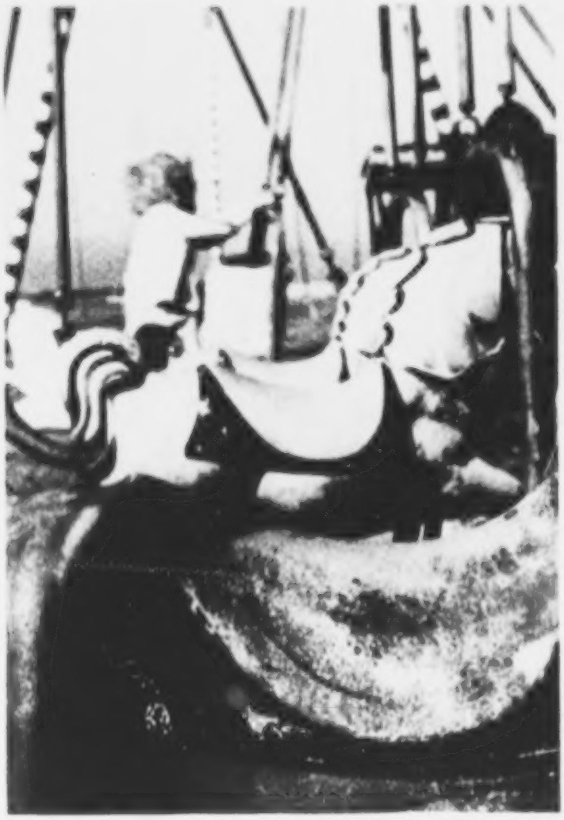


Figure 1-22. Selective focus showing background blurred.

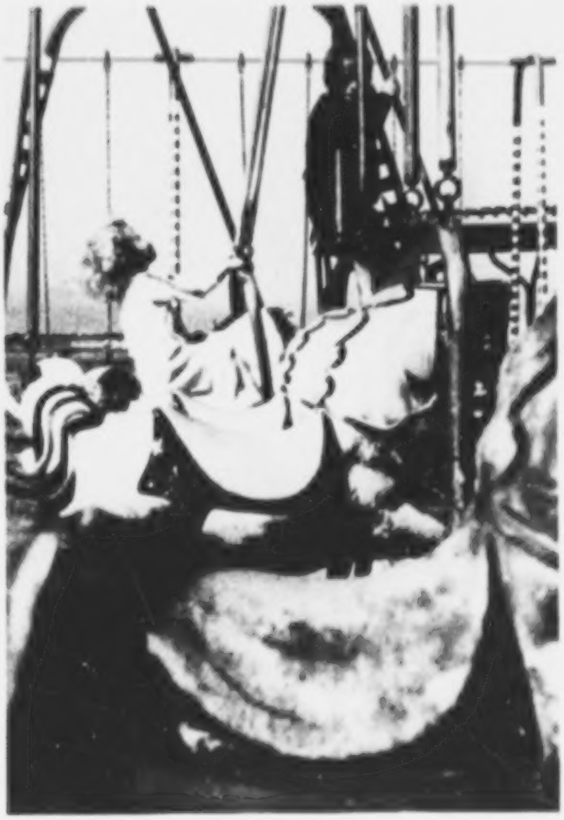


Figure 1-23. Selective focus showing foreground blurred.

Interrelationship of Subject Matter Parts. The more objects that are in the picture, the more challenging it is to achieve a harmonious arrangement. Many times you will not be able to move the subject and must depend on camera angle, shooting distance, lens selection, etc., to achieve a pleasing composition. When you can arrange the subject matter, the arrangement rather than the "taking of the picture" will likely make the difference between success and failure.

Use of Equipment. The proper selection of equipment can help you effectively complete your assignment. Filters, lenses, and lighting equipment all can help to achieve unique results. A "fisheye" lens can give you a cylindrical picture, a diffusion filter will soften the image, or a multi-image filter can give you special effects. You must therefore be aware of the continuing advances in equipment that permit you to extend or achieve a particular vision.

Selective Focus and Depth of Field. What should appear sharp in the photograph? The point of critical focus and the degree of depth of field will determine just how much of the photograph appears sharp. What appears sharp will certainly affect the character of the point of interest. The difference that can be achieved by changing your plane of focus is illustrated in figures 1-22 and 1-23.

Tone and Contrast. In black-and-white photography, the rendering of the subject in various shades of gray and the contrast relationship of these shades is very important in determining the final visual effect. The selection of the subject, background, foreground, and lighting creates a critical combination. Remember, the tone of each element will be determined by how much light it reflects. The more light, the lighter will be the tone. In this regard the appropriate use of a filter can be particularly helpful, especially when different colored objects may be reflecting the same amount of light. The selection of your film/developer combination will also have an important bearing on your recording. It is best to think about all of this when you are shooting, rather than rely on darkroom manipulation. Notice the difference that tones and contrast make in figure 1-24.

NOTE: In color photography the relationship of all the different colors is of great importance on what impact the photograph will have on the viewer. In fact it is the pattern of colors rather than the form and content of the subject matter that often dominates.

These have just been a few suggestions you can consider. See what YOU can do. Take PRIDE in your work. Always be in "student status" so that your work will not get stale.

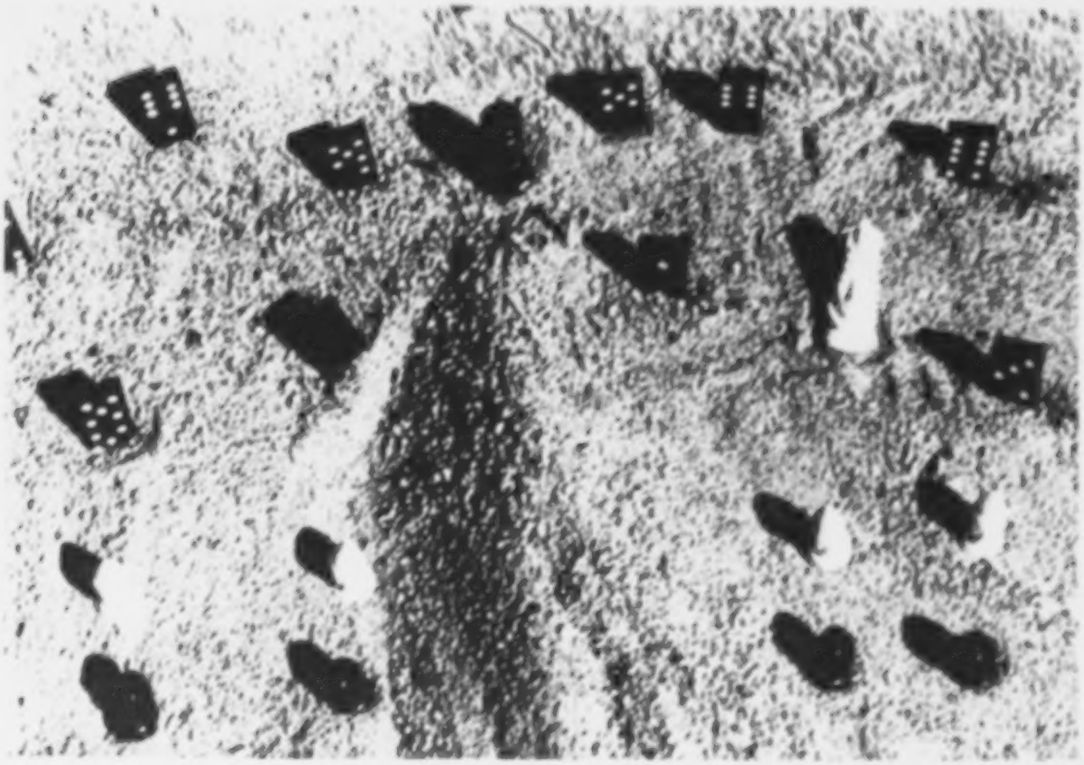


Figure 1-24. Use of tones and contrast.

Exercise (402):

1. Briefly explain how each one of the following is used to achieve creative compositions:
   a. Camera angles

   b. Interrelationship of subject matter parts

   c. Use of equipment

   d. Selective focus and depth of field

   e. Tone and contrast

General Assignments

A PHOTOGRAPHIC WORK order simply states a desired result that must be provided. Your supervisor's task is to determine the course of action to be followed to give the user the best quality work available at the least cost to the Air Force. As you can understand, this requires planning for the entire task.

Each photographic facility has its own set of conditions, such as personnel, workload, and equipment. Photography is not a field where there is only one set method to accomplish each task. Therefore, many factors must be considered in determining how a job is to be carried out.

It is important that when are called upon to carry out a mission, you are aware of what is required. In this way you can apply the skills you are mastering to get the necessary results. In this chapter, we will discuss many of the various types of missions you may be assigned to do and some of the basic techniques you may want to use.

2-1. Mission Planning

When a basketball coach calls a time out it is to plan the next line of attack. A football coach does the same thing. Before you drive from Los Angeles to Omaha, you would look at a map and plan your route. Before you shoot a photo mission you must also plan what you are going to do and when you need to do it.

This section deals with your planning. We include coordination, selecting and inspecting equipment, and loading film holders. All of these factors are important to your mission. So remember, plan ahead.

403. List the items of information needed to coordinate with the requester and/or Office of Information (OI).

Coordination. Suppose you are invited to a friend's house for a party. You will want to know if it is a casual party, a costume party, or a pool-side party. You probably don't want to make a fool of yourself. So you will coordinate with the party giver. You really don't want to show up in your swimming suit for a sit-down dinner.

In nearly everything you do, you have some type of coordination to do. In photography you also must coordinate. Suppose your request calls for shots of some wall charts. Do you know how big the charts are? Are there plenty of electrical outlets in the area? Is there enough room for you to move about?

All of these questions and more must be answered before you show up. This is your coordination with the requester. Find out exactly what is wanted and under what conditions you will have to work.

You need to find out whom to report to. You need to know if transportation will be provided or if you have to get there yourself. Most of this information is available on the AF Form 833, Request for Audiovisual Services (remember from Volume 1), but it never hurts to do some extra coordination.

Your request may come from the Office of Information (OI); you still need to do some coordinating. Answer all of the questions just asked and some more. Will an OI person be with you? Will the OI provide transportation? Is there a short suspense? Will you need proofs?

The whole point of coordination is defined in the dictionary "As the state of being in harmonious adjustment." That is, you know what is expected of you, what you can expect from the requester, and what the final outcome will be.

Exercises (403):

1. List three things you should find out when you coordinate with the requester or OI.

2. What Air Force form will assist you the most in your mission coordination?

404. List the factors which must be considered in selecting equipment and materials for an assignment of any type.

This next section is a continuation of your coordination. When preparing for an assignment you should consider three factors—the product desired, the shooting conditions, and the time requirements.

Product Desired. Whether the requester wants slides, color, or black-and-white prints, or combinations of these will set limits on your choice of film, processing, printing, and camera equipment. For example, slides require the use of a 35-mm camera, reversal color film, and appropriate processing. This film restriction alone may preclude your choice to one camera. The requester may instead want both color and black-and-white prints. Color negative film can give you both products, and it is available in a wide variety of formats, so your choice of a camera becomes much greater.

Shooting Conditions. The who, what, where, when, and why of your assignment will be the biggest factors in your equipment and film choice. A few examples will illustrate the problem. An architectural assignment normally calls for a view camera and the necessary cut film. A crash and accident can be best handled with a press camera and roll film or film packs. A football game is easiest to shoot with a 35-mm reflex camera and a variety of lenses. Whether the event is indoors or outdoors, daylight or nighttime, or on a beautiful sunny day or in downpouring rain will, for example, call for decisions on film speeds and accessory lighting.

Each job should be analyzed in terms of additional equipment as well. A view camera, for example, requires a sturdy tripod and a cable release. Filters are often required for accurate tonal rendition or color balance. You should always carry a properly working light meter. Remember, there is nothing more embarrassing than to travel for an hour or two to the shooting spot, get set up, and then realize that you have forgotten a piece of equipment that will make the difference between a "half-baked" job and success.

Time Requirements. Considerations of time may require particular equipment solutions. For example, a quick identification picture may be satisfied with an instant picture camera. A job that requires only a few shots, but has a "short fuse" on delivery may be best handled with a 4 x 5 press camera and cut film.

It must be stressed that you should carefully analyze your work order prior to going out on a job. You should develop a standardized checklist that should be followed so that you have the equipment you need with you. Such preparation will save you time in the long run because it will reduce the number of reshoots and it will prevent your shop from getting a poor reputation.

Exercise (404):

1. List the three factors that should be considered when choosing film and equipment. Briefly explain why each is important.

405. Cite techniques and procedures used in the inspection and testing of photographic equipment.

Visual Checks. Visual checks of camera and lab equipment give a good indication of their condition and usability. This visual check shouldn't be a quick glance but a thorough examination of condition. For example, suppose you are checking a camera bellows. A casual examination of the item may indicate incorrectly that the bellows is in perfect condition. Instead, extend the bellows to its maximum and, in a darkened room, place a light inside. If you cannot see any light leaks, the bellows is in good condition. Examine all items with the thought in mind that something is wrong and prove to yourself that they are all in satisfactory condition. It is surprising how many pitfalls you can avoid by looking for trouble in advance.

Operational Checks. Operational checks should be performed on each item of equipment. There is a danger of losing a photograph by a mechanical malfunction. This applies to lab equipment as well as the camera and accessories. Any item that must function to contribute to the final product should be considered as a possible trouble spot. For example, without a functioning focal plane shutter a 35-mm reflex camera can become a useless object. Therefore, you should check the camera shutter very carefully prior to going out on a mission.

There is a tendency to let seldom-used items, such as tripods and filters, slip by in the initial test. We may use a press camera daily and yet use the filters or tripod less often. Don't let such usage lead you into a sense of false security. Check each item against a checklist that you have prepared.

Preventive Maintenance. Preventive maintenance might be defined as those minor maintenance procedures which are performed to prevent excess wear or other damage to equipment. A small amount of oil on a squeaky bearing may prevent such a bearing from becoming damaged. Such preventive maintenance is mainly up to you and your common sense. It may include simple techniques such as tightening a loose screw or greasing a gear. Such maintenance will prevent costly breakdowns. Let us consider three general categories of preventive operator maintenance—adjustments, cleaning, and lubrication.

Adjustments. Adjustments must be made periodically if top quality results are to be expected from your camera and lab equipment. Technical manuals for each piece of equipment contain the procedures for making any required adjustments such as zeroing a light meter needle. When you do make an adjustment, be sure you follow the proper procedures.

Cleaning. All equipment, whether it is constructed from wood, metal, glass, or plastic, should be kept clean. Dust or dried chemicals can raise havoc in any photographic process, from the beginning to the final product. All cleaning should be done with the appropriate cleanser for what is being cleaned.

Lubrication. Periodic lubrication of any functional camera and lab equipment is a necessity. Points where friction is created will wear any time the correct amount or correct viscosity of the lubricant is not maintained. On any equipment, the unit, its location, the method of application, the lubricating period, and the type of lubricant are specified in the applicable technical manual.

NOTE: Remember, the extent of operator maintenance may vary from one laboratory to another. Limitations are due to the availability of maintenance personnel, the time it takes to send out a piece of equipment for repair, and the applicable regulations and technical orders which spell out areas of responsibility.

Exercises (405):

1. What is the purpose of a visual check?

2. Why are operational checks important?

3. What is the advantage of performing preventive maintenance?

4. List and briefly explain three techniques that are applied in preventive maintenance.

5. What limitations can there be on operator maintenance?

406. Point out principles and techniques pertaining to film loading procedures.

Cut Film Holders. Of the various types of films available, cut film is often used in the photo lab. Each sheet is independent of the others. One sheet can be exposed and processed by itself as opposed to roll film which cannot be economically exposed and processed for only one shot. Since many of your photos will be taken on cut film, you must learn how to load a cut film holder.

Preparation. Since holders must act as lightproof containers for the film, it is important that each slide be checked for breaks or cracks along the edges. The two hinged endgates of each holder should be opened and inspected for tears and holes. Replace each darkslide by placing its leading edge squarely into the light trap opening (never with one corner only and pushing diagonally) and by pushing evenly until the slide is seated in the groove of the closed endgate.

At this point and throughout your photographic training, bear in mind that cleanliness in all operations is a "must." Film is manufactured and packaged under sterile or "white-glove" conditions to assure its freedom from all defects. The loading room must be lightproof, clean, and dust free; the bench or table on which loading is performed should be cleaned with a damp cloth.

Remove dust from the darkslides of a film holder before withdrawing them through the light trap. Then use a soft, camel's-hair brush to clean the insides of each film holder. After cleaning the holders and darkslides, reinsert the slides with the silver side of the tab facing outward. Push the darkslides in just short of the point at which the slide begins to cover the film area. Stack the holders in piles that are convenient to reach. Then remember where you put them because you will have to find them again after you turn the lights out.

Film. Cut film is packed in boxes containing anywhere from 10 to 100 sheets of film. Sometimes, sheets of black paper separate each sheet of film. The film is protected from bending and cracking by two pieces of cardboard. The entire package is wrapped in a single (or double) thickness of black paper for protection against light. To protect the film from outside moisture, the entire inner package is sealed in either metal or plastic foil. The sealed package is then put into a three-part, light-tight, cardboard box that has a seal of its own.

You must be careful when removing film from its box to prevent fingerprints, scratches, dust, or lint from ruining the film. To do this, always handle any sensitized material by its extreme edges only. If your hands perspire freely, rinse them in cool water and dry thoroughly on a clean towel before handling film.

Each sheet of cut film is notched along one edge according to a code established by the manufacturer. The notching code serves two purposes. First, it identifies the film you are loading; second, it helps you to identify the emulsion side of the film while loading or processing. In order for you to load a holder correctly, you must know which side of the film is the emulsion side.

Loading. Typical film notches are shown in figure 2-1. When the film is held vertically with its notches in the upper right-hand corner, its emulsion side will face you and can be slipped into the holder in its correct position. If the film is held horizontally, the notch will be in the lower right-hand corner. In either case, make sure that the sheet of film is under the lips on either side of the holder's frame and just below the light trap. When the hinged endgate is pressed into place, the film base will lie flat against the metal plate inside the holder. If the film is not seated under the lip by the light trap, the endgate will not close fully. Figure 2-2 shows how to load each sheet of film.

As each side of the holder is loaded, push the darkslide in place until it is seated in the groove of the endgate. Only when the darkslide is inserted squarely

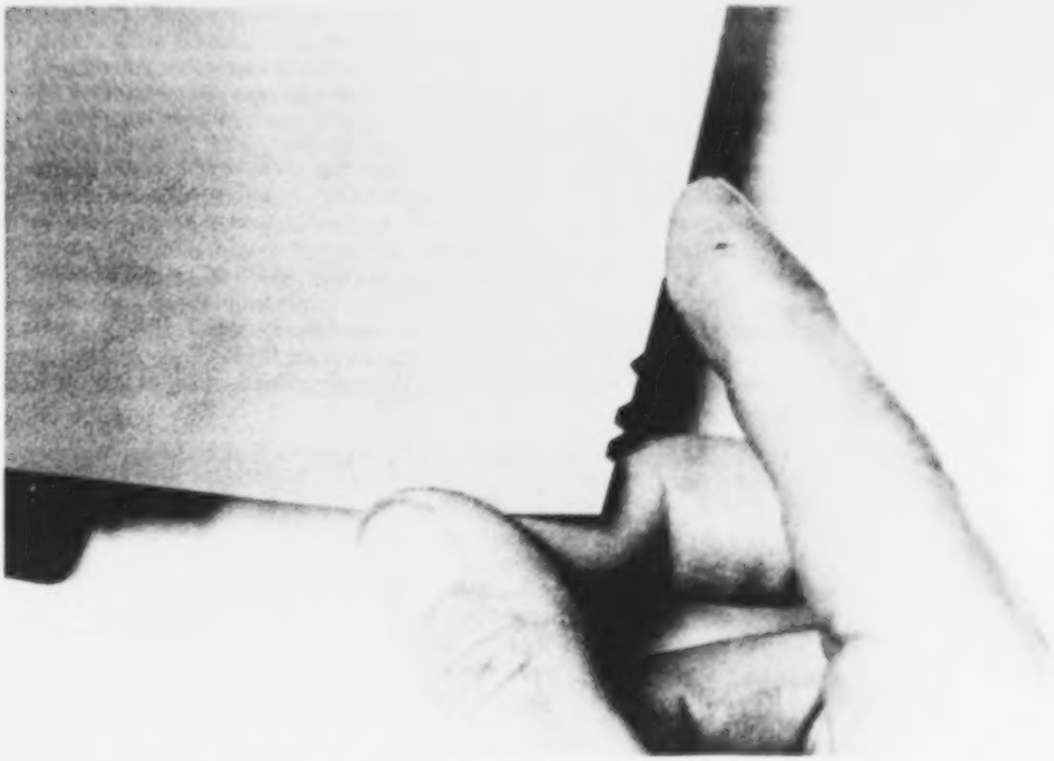


Figure 2-1. Film notches.

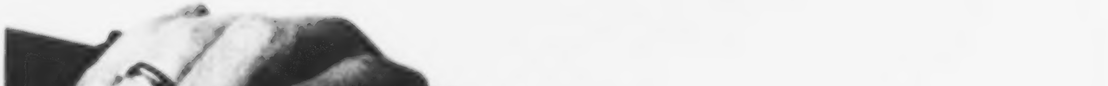


Figure 2-2. Loading a film holder.

will it slide in place easily. Before inserting the darkslide into the holder, check the raised dots along the metal strip at the top of each slide to insure that they are facing outward. These dots are only on the silver side of this metal strip, which indicates that the holder is loaded with unexposed film.

When all holders are loaded with fresh film and when their darkslides are replaced, turn the small locking pins so that each pinhead projects over a slide. The locking pin prevents a darkslide from being accidentally withdrawn and ruining the film when you are handling the holder on a mission.

After removing the required sheets of cut film from the inner package, carefully rewrap the remaining film in the black wrapping paper and return it to the cardboard box. Turn the lights on; then tape the box shut and label it with the number of cut-film sheets remaining, the date, and your name.

Film Pack Holders. A film pack is a thin metal container which holds 12 or 16 very thin sheets of film. Each sheet of film is attached to an opaque sheet of black paper called a tab. Before use, all of the sheets of film face toward the opening in the front of the metal container. The pack of film is held in place by a spring-loaded pressure plate. Between the first sheet of film and the opening in the frame there is a protective cover with its own tab.

Before you can use the film pack, you must remove the protective cover over the first sheet of film by pulling on the attached (0) tab. Instantly, the pressure plate pushes the first sheet of film up against the retaining frame surrounding the opening. The black paper on the back of each sheet of film protects the sheet behind it from exposure by transmitted light. After exposing the first sheet of film, pull the number 1 tab. This pulls the sheet of exposed film around the end of the film pack and positions it behind the remaining film. The diagram in figure 2-3 shows the principle of the film pack. As the first film is pulled around to the back, the second sheet is uncovered, and the pressure plate forces it into the correct position for exposure. This procedure is continued until the last piece of film has been exposed and has been pulled to the rear of the pack. As you pull the last tab, the pressure plate spring forces the pressure plate into the pack opening, creating a light-tight seal.

In order to use the film pack, you must place it into a film pack adapter as shown in figure 2-4. This procedure is really rather simple. All you have to do is release the spring catches, open the adapter, and put the film pack into place. Remember to have the opening of the film pack container facing the opening of the adapter.

Roll Film Holders. Some Air Force cameras are designed primarily for using sheet film, but special holders are available to adapt such cameras to handle roll film. Other cameras are designed specifically for roll film with built-in or detachable film holders. In either case you will have to load the roll film holder. Typical roll film holders are shown in figure 2-5.

The front part of the holder fits flat against the back of the camera. A darkslide permits you to remove the holder from the camera in the middle of a roll of film without exposing the film. Parts of the roll film holder keep the film in place, hold it flat, and move it from one exposure to the next.

Since there are so many different types of roll film holders, the following discussion will be very general.

Preparation. As with cut film holders and any other photo equipment, cleanliness is very important. Before you load film into the magazine, clean the surfaces where the film will rest, make sure there are no light leaks, and check that any parts that are supposed to move do so freely.

Some magazines have exposure counters that have to be set when the film is loaded. If you are using such a magazine, be sure you set this counter where it belongs.

Loading. All of the roll film holders have some type of rollers or bars that you must guide the film around. Check the owner's manual to be sure you position the film where it belongs. As with any camera equipment, do not force anything on or onto the roll film holder.

Exercise (406):

1. Complete the following statements:
   a. Film holders act as ____________ containers for film.
   b. The room used for loading film holders should be ____________ , ____________ , and ____________ ____ .

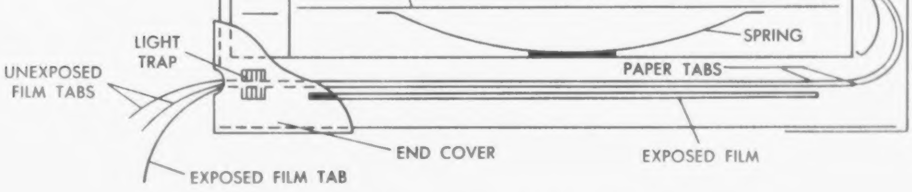


Figure 2-3. Diagram of a film pack.

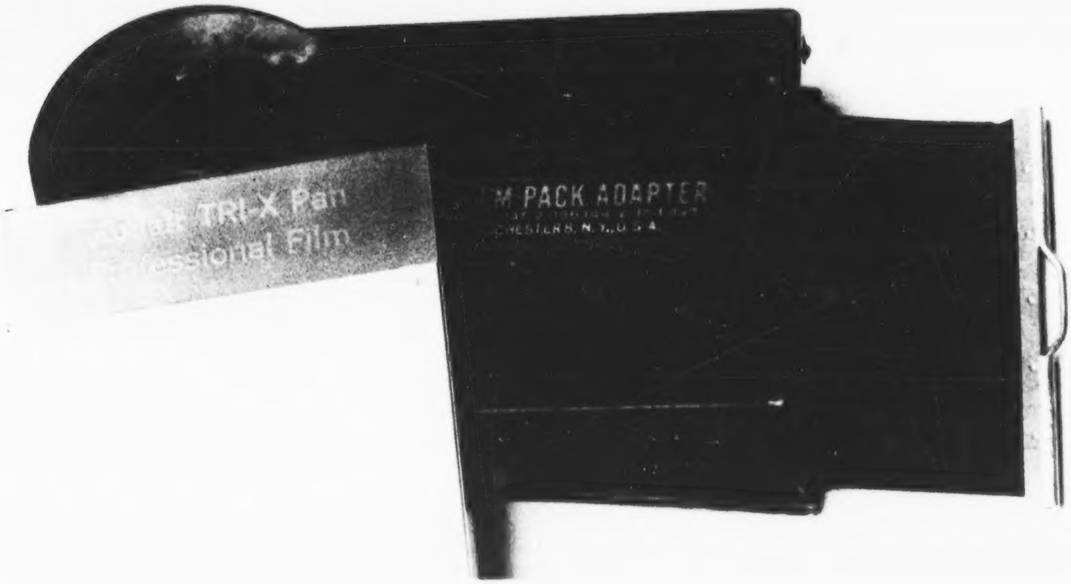


Figure 2-4. A film pack adapter.

c. If the notches of a cut film are in the upper right-hand corner, the emulsion side is ______ you.

d. When the raised dots of a darkslide are facing outwards, the film holder has ____________ film in it.

e. A film pack contains ________ or ________ sheets of film.

f. To use a film pack, you must place it into a _________ _________ _________.

g. The front part of a roll film holder fits against the ______________________________ .

h. Before you load film into the magazine, ______ _________ the surfaces where the film will rest.

i. Roll film holders have some types of ______ or ___________ that you must ___________ the film around.

2-2. Basic Photojournalism

Photojournalism is the means of telling a story with photographs supported by captions or a written story. The titles to the story, text, and captions are used to introduce, hold together, and fill in the blank spaces of the story.

Photojournalism, the artful combination of words and pictures, is a vital part of modern news reporting. Some of the leading national magazines and a multitude of newspapers today attribute their success to photojournalism. The reason for this is simple—pictures can portray at a glance the essence of a news or feature event. Action-packed pictures with carefully worded captions have several times more reader appeal than printed news stories alone. Pictures that capture the essence of a news story or develop a feature on some aspect of Air Force life are definitely in demand today. We don't expect you to become an accomplished photojournalist, but you should know some of the basic elements before you go out on a mission.

407. List the three steps necessary to develop a story idea.

Developing the Idea. In most cases, stories develop from an idea. In your case, the story and idea will probably be assigned to you rather than your coming up with them yourself. However, you must know how to develop the story idea. This is really still more of your planning and coordination. The idea includes a specific story topic conceived to appeal to the reader audience. Unlike a spot news item, the picture story

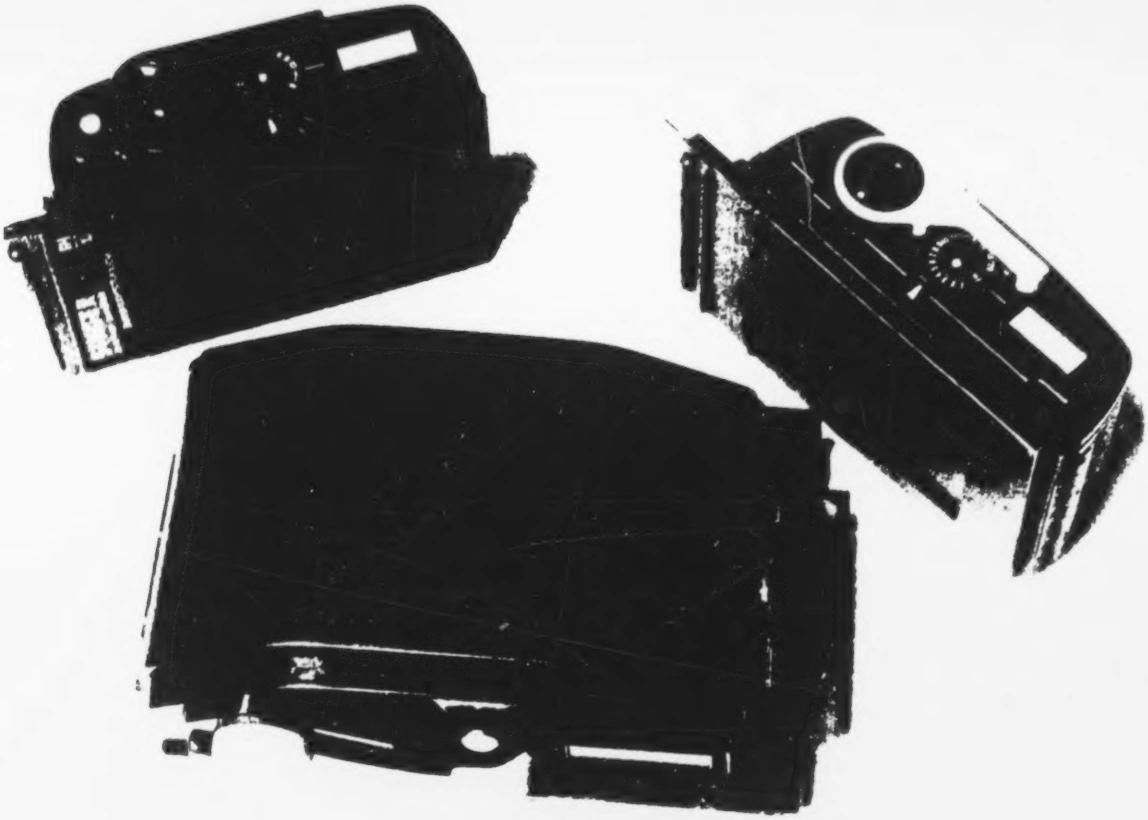


Figure 2-5. Roll film holders.

is actually designed to convey a message intended to appeal to the experiences and feelings of large masses of people. However, you must take care to keep the idea within well defined limits.

For example, to make an in-depth photographic narrative on the 30th Group at Lowry would require a lot of planning and a considerable amount of time for execution. Such a giant task may not be suitable for a picture story. However, covering a specific course, such as the Photojournalistic Techniques Course, would reduce the complexity of the task. You may even reduce your effort by covering just one instructor or student. Each of these steps down is designed to keep your idea within workable limits.

This first step in story development cannot be taken lightly. Keep in mind that you must plan your idea to stay within workable limits.

Research. The next step is research. Become familiar with the background of your subject and try to learn what can be expected in the future. Talk to the people involved. Know what to expect on the scene so that you can plan your shots. By identifying key reader interests, you may reveal various lead pictures. Research can open an avenue of approach for execution.

Prepare the Script. The shooting script is the third step in developing your story idea. A shooting script is a source of valuable information. It should specify camera angles, lighting, and subject arrangement. A script may contain detailed instructions for staging an event, or it may contain general information about an uncontrolled event. In either case, the script is a guide that may be changed when the necessity dictates. When on assignment, you can "wager your lenscap" on the possibility of an unplanned incident occurring. Therefore, you should be alert and aware of everything going on around you all the time. An unplanned incident may give you the best shot of the assignment. To catch an unplanned shot, and then continue with the script without wavering, is the mark of a professional.

To maintain continuity in your stories, you should always plan shooting scripts. Also, a shooting script provides added assurance for the experienced photojournalist. A script can serve you in much the same way that a planned route through a busy metropolis serves an unfamiliar traveler. A script is a lifesaver in a maze of action and activity.

Exercises (407):

1. What are the three steps in developing a story idea?

2. What is the most important aspect in developing your idea?

407a. (433—for CE feedback reference only). Briefly state how a photographic layout is developed.

Planning the layout. A layout is the plan for placement of photographs on a picture page. It is much like the plans and models made for houses. It shows what the completed job should look like.

Layout of a picture story or photo feature, whenever possible, should be coordinated by the photographer and the editor. This insures continuity and resolves problems before publication.

When called upon to make a layout, obtain all the data relative to the job. Start the layout with a number of small thumbnail sketches, keeping in mind where you will place the lead picture and supporting photographs. The lead, or key, photograph should immediately catch the viewer's interest and lead the eye to the rest of the display. It should express the central theme of the story and be placed in a predominant position of the layout. Generally, the lead or key photograph is larger than any of the other photographs.

Once the rough layout has been accomplished, a comprehensive layout or visual sketch can be completed. Photos are then arranged to catch the reader's eye, in addition to the logical progression of the story.

Exercises (407a):

1. How do you develop a photographic layout?

2. Who should be involved in the planning stages of a layout?

408. Indicate whether given statements correctly reflect the writing of captions and cover stories.

A missile launching may make an exciting picture, but it fails as a news picture unless the reader can understand the when, where, and why as well as the obvious what and how. To fill in the spaces that the picture by itself leaves, you need to write captions and cover stories.

Captions. There are probably as many different ways to write captions as there are photographers. These ways vary in their worth according to how well they supplement and clarify the picture. The elements that make up a good caption are used by nearly all caption writers in one form or another. We include here the four elements and a description of each.

Explanation. The first sentence is the most important one in a caption. It must link the photograph to its caption by describing the action in the photograph. One of the peculiarities of the first sentence is its verb form. The verb in the first sentence of a caption is usually in the present tense. The reason for this is that photographs, like paintings and sculpture, capture one moment of time and keep it in the present. Just as a painting depicting Washington crossing the Delaware captures that moment of history in the present for as long as the painting itself exists, so a photograph captures one moment of history, whether dramatic or mundane.

Another reason for using the present tense in the first sentence is that it gives the reader a sense of immediacy, as though he were actually witnessing the event shown. Thus, a caption reads, "Airman James T. White swims through swirling flood waters of the Colorado River to rescue 6-year-old Ruth Gray. . . ." has more dramatic impact than one which reads, "Airman James T. White swam through. . . ."

One problem which arises from the use of present tense in the first sentence is what to do with the when element. To put the time element in the first sentence would result in a sentence such as, "Steve Garvey hits a line drive to center field yesterday. . . ." Needless to say, this is somewhat jarring to the reader and should be avoided. To alleviate this problem, the time element in captions is usually left out of the first sentence. This avoid awkward sentences with a shift in tense such as the one just quoted.

Identification. The second part of the caption is the identification. This includes the identification of all persons and things vital to the storytelling function of the photograph. The question of who should be identified is, of course, the biggest problem here, and only general guidelines can be given to help the caption writer. There is no magic formula for every situation. Everyone should be identified who is identifiable and pertinent to the story. By identifiable, we mean a person who is not blurred or obscured or too far away for recognition. By pertinent, we mean a person who is involved in the central action of the picture. It should be noted, however, that anyone in a photograph who attracts the reader's attention should be identified. The reader's curiosity should never be frustrated.

The next question concerning identification is where it should be placed in the caption. The best answer to this is that it should come as soon as possible in the caption. Many times you can identify people at the same time the action is described. For example, in the statement "Sergeant John P. Woods sounds Taps to climax Memorial Day ceremonies . . . ." the identification is included as the subject of the action. Sometimes, however, it is better to use an impersonal identification in the first sentence. In that case, the complete identification should come in the second sentence.

The only exception to this general rule is in the case of group identification. When there are several people to be identified in a photograph, it is better not to clutter the first two sentences with a list of names. This is apt to discourage the reader from finishing the caption. The recommended way to handle a group photograph is to use an impersonal identification in the first sentence (such as, "A group of airmen. . . .") and then list the names in the caption. This achieves complete identification without cluttering the important first sentence.

The identification itself can be handled in one of several ways. The idea is to handle it in the most natural and concise manner consistent with clarity. The best way to identify people is by action. If John Smith is passing a football to Sam Brown, it should be obvious from the photograph which one is passing and which one is receiving the ball. Thus, they are identified by their activity and you need not use left-to-right identification.

Another simple manner of identifying some members of a photograph is by obvious contrast. If there are two airmen and Miss America in a picture, it is not necessary to identify Miss America as being left of center. She is well identified by obvious contrast, and place identification would be superfluous.

Slightly more complex is identification by elimination. Suppose there are three people in a picture (see fig. 2-6). The general is pinning officer's bars on the recipient. These two are identified by their action. The remaining person, obviously the recipient's proud wife, is identified by elimination.

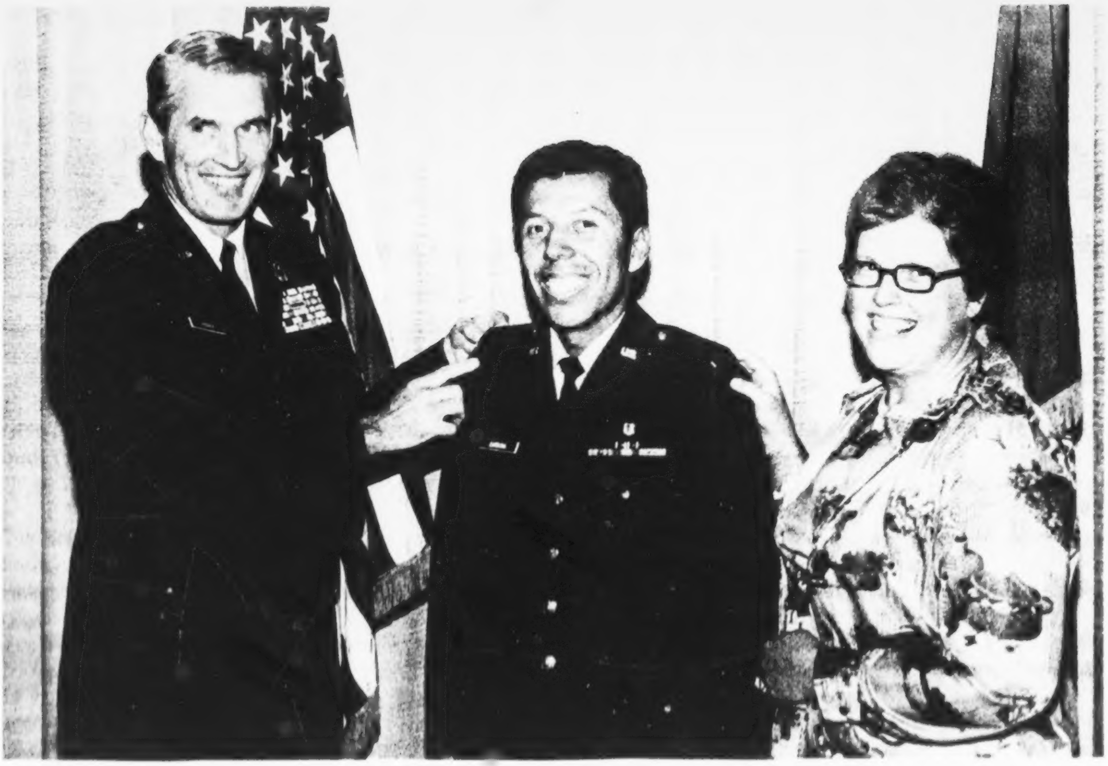


Figure 2-6. Identification by elimination.

Finally there is the traditional left, right, center, or from left identification. It is not necessary to say from left to right. This wastes space. If one starts from the left, there is no place to go but right. This place identification should be used whenever other means of identification do not suffice, or when there is a chance of confusion.

Background. The third element of the caption is the background information. This consists of additional facts or explanations needed to clarify the photograph. The length of this section of the caption further depends upon two factors; where and how the photograph is to be used. The consideration of where the photograph is to be used refers to the question of whether the picture is to be printed in a military or a civilian publication. The amount of background information needed to explain a photograph of bayonet practice to a civilian reader is obviously greater than that needed to explain it to a basic trainee who is participating in such practice.

How the photograph is used refers to whether the picture is to be used alone, as an illustration for a story, or as a part of a picture story. If a picture is to accompany a news story, the caption need not duplicate details used in the story. However, if the picture is to be used alone, the caption must be longer to offer maximum information.

Captions prepared for picture stories are similar to those written for single pictures, except that a story is told by means of a series of related pictures. In this case, a main caption, usually written for the lead or key picture of the story, can supply background information for the entire story.

Credit Line. Most service newspapers use credit lines for photographs. There are several ways of crediting photographs. Some newspapers give photographers personal as well as official service credit lines. Others use a blanket statement that all the photographs are USAF (Navy, Army, Marine) photographs. Yet, the usual way is to put the credit line at the end of the caption itself. The credit line, which follows directly after the last word of the caption, is entirely in capital letters and is inclosed in parentheses in the following manner: (US AIR FORCE PHOTO).

Cover Story. A cover story is really no different than your captions. The only major difference is that the cover story is a larger caption. The cover story is the culmination of all of your captions.

You apply the same principles and techniques in writing a cover story as you do in writing your captions. Include the five Ws (who, when, where, what, why). Also, make sure that you include the information that the pictures do not clarify. Do not include information in your captions and cover story that is obvious in the pictures.

The culmination of your pictures and writing will allow you to become a writer with pictures—that is, a photojournalist.

Exercises (408):

1. From the following statements about captions and cover stories, select those that are true:
   a. There is only one correct way to write a caption.
   b. The first sentence in a caption is the most important one.
   c. Use a present tense verb in the first sentence to give a feeling of immediacy.
   d. There are specific guidelines to follow when you need to identify who is in a picture.
   e. You should use "left-to-right" identification if there is a chance of confusion.
   f. The credit line is normally placed at the lower left corner of a photograph.
   g. The techniques of writing a cover story are much different than writing a caption.
   h. The five Ws should be included in a cover story as well as in a caption.

2-3. Sports and Action Photography

Every base newspaper has a sports section to display top photographs. Both players and spectators enjoy action-packed shots that sum up the excitement of the various events. Whether it is shooting a squadron softball match, an interservice track meet, or the Olympic Games, there are plenty of opportunities for the sports knowledgeable photographer.

When we think of action photography in the Air Force, combat action comes immediately to mind. Combat action may be air-to-air or air-to-ground. It may be some form of ground support action. But no matter what form the action takes, it demands that you cover it from all angles or positions, in all kinds of weather, and under all light conditions. A combat photographer takes the risks of war to inform his commanders, comrades, and the American people what the Air Force is doing. It is the most challenging and demanding of any assignment a photographer can get. Yet, it is the ultimate purpose of every Air Force photographer's training.

409. State principles, techniques, and requirements of sports and action photography.

Sports Assignments. The first step in a sports assignment is preparation. You must research the sport. Usually, the sports assignment goes to the cameraman with an interest and knowledge of the event, and you may meet these requirements. But regardless of your knowledge of the sport, it pays off to refresh your knowledge by researching the players. Players are specialists in their field. Some break fast and move with deceptive speed. Others excel under the basket or at bat. Know the players and their characteristics. With this knowledge you can get the jump on the action when it is at its peak. For example, if a ballplayer known for his base stealing prowess is on first base, you should be ready for the action of a steal. You should also know the stadium where the event will take place so you know the possible shooting positions.

Equipment. The speed of action demands choosing equipment that is designed for stop-action photography. Whenever available, use a 35-mm reflex camera, variety of lenses, high shutter speed, strobe lighting, fast film, and a motor drive. A motor-drive attachment on your camera enables you to shoot photo sequences almost as if you were using a "movie" camera. An exposure that is a little too late or a little too early isn't good enough. The punch in sports photography lies in recording the instant when the player's intensity of expression and effort are at their peak.

A telephoto lens is indispensable for bringing the action in close. The camera position and angle, as related to the action center, often prevent getting the shot with a normal lens. A telephoto lens lets you get into the action and catch the intensity of the player. Many sports activities take place under lights, or under conditions that require supplemental lighting. Under these conditions the use of strobe lighting has become almost universal. The strobe is also ideal for stopping fast action at its peak.

NOTE: Remember to realize that a strobe has only one-fourth of its normal effect when used in a large arena or outside. In addition, make sure that your lighting does not interfere with the performance of the players.

Photographer's attitude. Shooting a sports assignment requires mental and physical agility to stay ahead of the play. You must anticipate the action. Be prepared. Move fast. Be alert for human interest shots off the playing areas as well, such as the expression on the face of the coach; or the excitement or despair of the crowd.

Action Photography. As a photographer you can expect to shoot action shots many times. Successful action photography demands highly developed techniques and ingenuity.

The word action means that the subject is moving. In action photography you will have a decision to make: Should I stop the action or emphasize it. That is, how should you show the action?

Stop action. There are two ways to stop the movement of an object on your film. The first is by using a fast shutter speed. The second method is called panning.

Use a fast shutter speed to stop the action of the object. A slow shutter speed will make the object appear to be blurred. Figures 2-7 and 2-8 show the use of fast and slow shutter speeds.

To pan, you follow the movement of the subject with the camera. During the pan you trip the shutter. This method will produce a subject that is in sharp

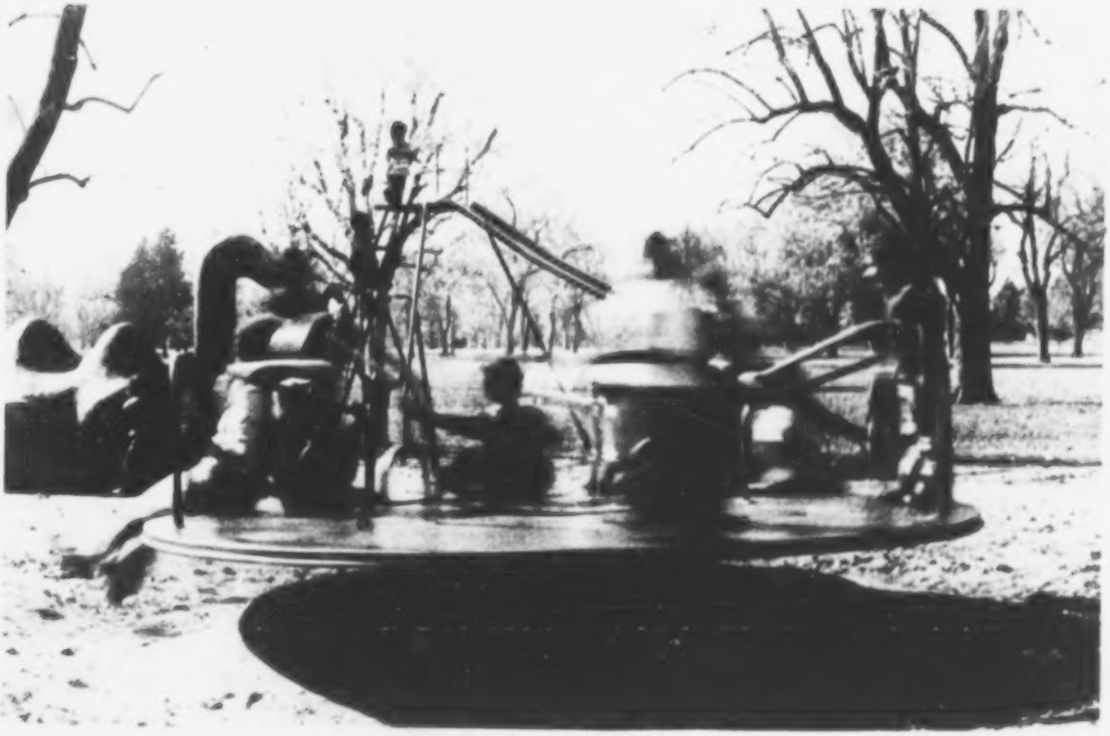


Figure 2-7. Slow shutter speed.

Figure 2-8. Fast shutter speed.

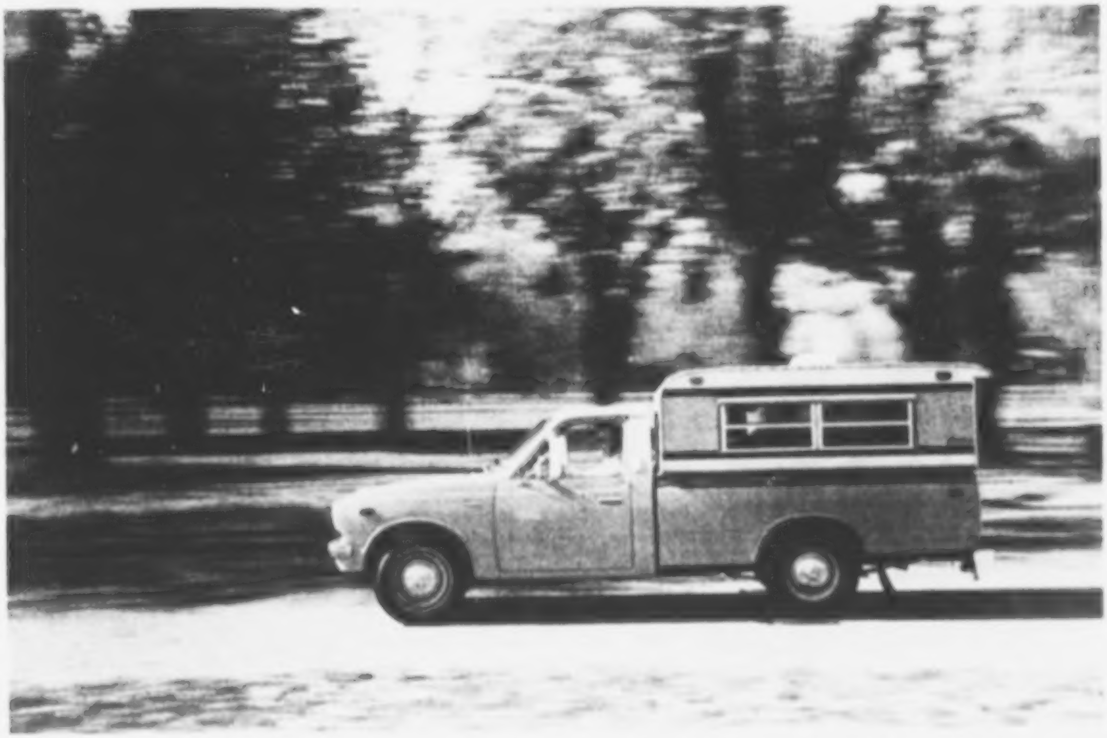


Figure 2-9. Panning.

focus and a blurred background. Figure 2-9 shows the use of panning.

Speed and angle. Two more things to consider when shooting action photography are the speed of the subject and its angle to the lens. If an object is moving fast you will need to use a fast shutter speed to stop its movement. The closer the object is to perpendicular with the lens, the faster the shutter speed you need to stop its action.

For example, if an object is moving very fast, it will be in front of the lens only instantaneously. So obviously you need a fast shutter speed to capture it on your film. If an object is moving directly toward you, a slow shutter speed will suffice. But if the object is moving perpendicular to your line of sight, you will need a fast shutter to stop its movement.

By remembering these action techniques, you can stop or emphasize the action. You know that a slow shutter speed will make the object appear to be blurred. A shot of a firefighter getting into his boots and coat, shot with a slow shutter speed, will make the firefighter appear to be blurred (fig. 2-10). This shot will emphasize the action even if the firefighter is a bit slow.

Panning is also effective if you want to emphasize action. Figure 2-11 shows a rather slow-moving subject that has been emphasized by use of panning.

Exercises (409):

1. What is the first step in a sports assignment?

2. What type of camera should you choose to cover a sports and/or action assignment?

3. What are the two ways to stop the movement of a subject?

4. A fast-moving object going directly in front of you would require what kind of shutter speed?

5. If an object is moving directly toward you, is its movement and speed emphasized?

410. Cite selected techniques of combat photography.

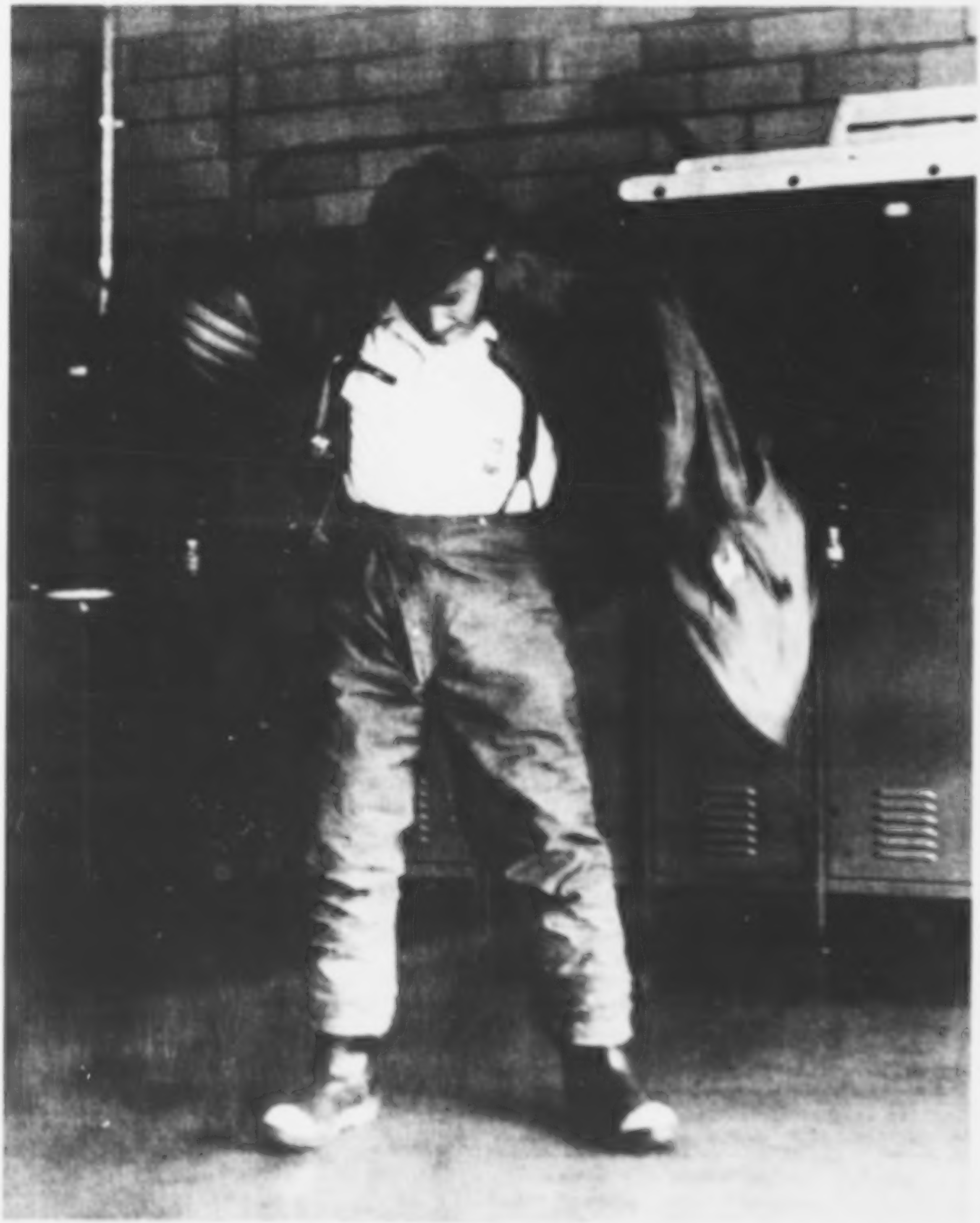


Figure 2-10. Blurring caused by slow shutter speed.

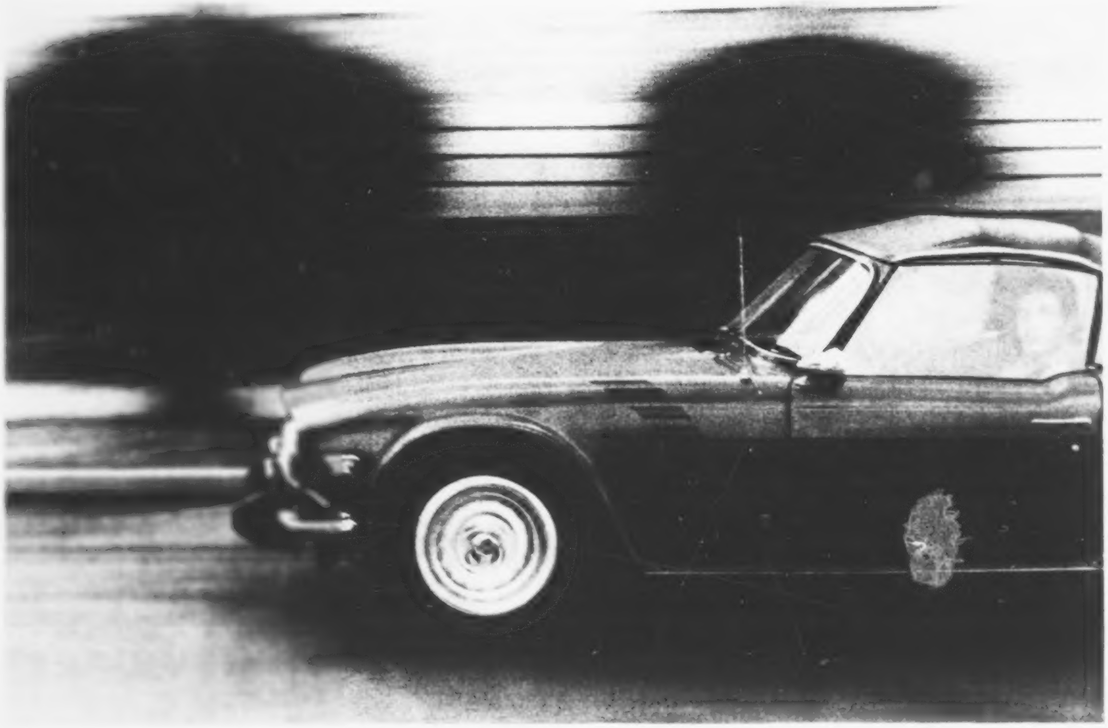


Figure 2-11. Use of panning to emphasize motion.

The ultimate of action photography is combat photography. Hopefully, you will never have to function as a combat photographer. But since you may, we include the following information.

Combat Photography. Planning for this type of assignment is similar to sports planning in that you will be photographing uncontrolled action. In fact, it is far more uncontrolled; it goes forth, without rules, over a much broader "playing field" than any sports event. You must be in top physical condition because you will be required to fly combat missions as well as accompany ground troops in the field. You must be mentally alert and emotionally stable to capture the fast paced, death dealing events.

The equipment must be small and fast handling. Two 35-mm cameras (one rangefinder for its quietness and low light focusing capability and one reflex for telephoto work), a couple of lenses (examples, 28-mm, 50-mm, 80-210 zoom), filters, meter, film, a notebook, a couple of tools, and a cleaning kit are what you basically need. It is similar to what you might use in photojournalism, but with these thoughts in mind:

- You cannot use flash in a combat zone because it will attract the enemy. Therefore high-speed films are a must.
- You do not have time for a normal size tripod. Unless you have a photo clamp or table-top type of tripod, you must normally rely on natural objects or equipment to support your camera for any time exposures you might need.
- You must keep equipment to the base essentials because you will have to carry your military gear as well. On a flying mission you may be further limited because of space and weight requirements of the plane.
- You must be able to carry all the film you will need since it is difficult to be resupplied during field operations.
- You will often need to take care of your equipment yourself. You must protect it and the film from mud, water, sand, dirt, etc. Waterproof pouches come in handy for this task.

Here are a few shooting techniques you might consider:

- Use the wide-angle lens to get an overall view of the combat zone. This gives a good idea of the scope of the operation and the general positions of the forces.
- Use the telephoto lens to get you close to the action.
- Use the principles of framing and leading lines, etc., to draw attention to the key point of interest.
- Anticipate the high point of the action. For example, catching the bombs being released during a tactical air strike.

- Action at night can create dramatic silhouettes. Also, a nighttime exposure of the battle can give truly interesting results.
- Portraits of the soldiers and airmen involved are the most telling of all pictures. Such views show the tension, grief, pride, and the gut determination of our forces.

Exercise (410):

1. Complete the following statements on combat photography:
   a. Combat photography covers action which is far more ____________ than sports.
   b. You cannot use ____________ in a combat zone because it is likely to attract the enemy.
   c. Normally, you must carry all the ____________ you will need because of limited resupply.
   d. Wide-angle lenses are used to give an ________ view of the action.
   e. __________ __________ ______________ ____________ usually are the most telling of all combat pictures.

411. Specify selected techniques of group action photography.

So far in our discussion we have limited the subject to a singular object. But suppose you have more than one person or object in the scene. What other considerations do you have to deal with? These considerations are lumped into a part of your job we will call group action photography.

Group Action. We are still concerned with the action or movement of the subject(s). You must still apply the action handling techniques previously covered; also, you may have to improvise some action. New problems in group action photography are the group, what to do with it, and how to show its action.

Your first consideration is the size of the group you are trying to photograph. Obviously, a group of 3 or 4 people will be easier to deal with than a group of 126 people.

If you need a simple group shot, say of a top-flight squadron, make sure everyone's face is visible. The simple way to do this is to arrange the group and then ask if everyone can see the camera. If they can see the camera, then the camera can see them, and all of the faces will be recognizable.

Another problem with a large group is squinting eyes. Indoor shots are no major problem. Outdoors though, you need to be aware of the angle of the sun. Don't position the group facing into the sun.

Photographs of large groups are very static. That is, it is hard to show a squadron in action. Therefore, they are the exception to the "make sure everyone is doing something," rule. Which brings us back to small groups.

If at all possible, limit your group action shots to as few people as necessary to tell the story. In your small group, make sure everyone is doing something. Don't let one person adjust a dial while the other people in the group are standing around with nothing to do. In other words, don't let your pictures become static. Show some action is taking place, even if you have to improvise a little.

The easy group action pictures are the ones where the group is actually busy doing something. In these you won't have to improvise; the group is already busy. For example, an alert crew running to the crew truck actually shows action. However, the same crew waiting in the dayroom does not show much action. So to keep from having a static shot, you may have to improvise some action.

The main factor in group action is to show the group in action. Remember, don't let your photos become static; make sure everyone is doing something.

Exercise (411):

1. Complete the following statements by filling in the proper word or phrase:
   a. In group action photography you may have to ____________________________ the action.
   b. Your first consideration in group action photography is the __________ of the __________ .
   c. If all the people in a group can see the __________ __________ then the __________ can see them.
   d. Limit your group shots to ______________ ____________ people as necessary to tell the ______________________________ .
   e. Your main concern in group action photography is to show the group in ______________ .

2-4. Spot News

Spot news is not a picture of your dog pouring over the daily paper. Spot news is events that are happening and must be covered immediately. The discussions on photojournalism and action need to be remembered during this discussion, too.

412. Define "spot news" and tell how you can prepare to cover it.

Spot news coverage can be summed up in one word —URGENCY. You must arrive on the scene, get the coverage, and return to the lab to process and print your photos. All of this must be done in time to meet the deadline, sometimes in a matter of minutes.

Spot news events are those events that happen right now. An arriving dignitary, an airplane accident, or weather damage to your base are all spot news events. If you didn't get the shots during the event, you'll have a tough time getting your memories published in the paper. If you did get some shots, but too late, you didn't get news—you got history.

In addition to being on time, spot news photographs must have impact—both visual and emotional. They must tell a story that is complete and to the point. They do not have to be tear-jerkers. They can be humorous or informative. Whatever mood your pictures portray, it is only temporary. But you must capture the mood and get it to the audience immediately. If it's not out immediately, it isn't news.

Spot news assignments require that you give your best effort and ingenuity. It is, "Get your camera - NOW!" not, "Just a second, Sarge." You will not have time for researching, planning, organizing, and time-consuming preparation. Furthermore, spot news events are uncontrolled action situations, and your success depends on your ingenuity and awareness.

About the only preparation you can do is to be ready. Have your camera in top operating conditions at all times. You must get to the scene now—not after you have checked out your camera.

When you get to the scene, start shooting. While you are there, be aware of what is happening around you. Visual awareness will let you get the shot that makes the story. Be ready for it.

Your personal preparation may also help you in spot news assignments. You should be able to compute exposures, distances, angles, and positions almost automatically. While you are fumbling with an equivalent exposure, your counterpart is winning the Pulitzer Prize.

You will probably be on your own at the scene. Therefore, you are responsible for getting the shots. Keep your viewers in mind. They will see only what your pictures show them. So show them what happened.

When you have covered the news, get back to the lab, process the film, and print your best shots. Then relax because you have just covered a spot news assignment.

Exercises (412):

1. What is spot news?

2. How can you prepare to cover a spot news event?

2-5. Awards and Presentations

Every day someone in the Air Force gets an award. Since that person is proud, he will probably want a picture of the award ceremony. Since you are a photographer, you will have to produce the picture. And since you are a professional, you will want to do your best work. In this section, we give you some hints and techniques that will help you produce your best possible work.

As we said before, photography is an art form. Therefore, there are not too many strict rules for you to follow. In this section, we cover the guidelines that are known to produce acceptable products.

413. Cite selected techniques and principles for producing awards and presentation-type photographs.

There are four common awards and presentation ceremonies that take place in the Air Force. These are medal awards, trophies and certificates, promotions, and swearing in ceremonies. Except for swearing in, they all have certain things in common. That is, the recipient, the presenter, and the award. You need to know how to handle each ceremony and the participants.

Medal Awards. In the award of a medal, there are three elements involved. The order of importance is: (1) the recipient, (2) the medal, and (3) the presenter.

The medal will be pinned on the recipient's left pocket or breast. Therefore, you should shoot from that side. You may find it necessary to shoot from an angle that eliminates one of the participants. If this is the case, eliminate the presenter. You may want to shoot the presenter in profile. The point is, be sure you show the recipient.

Sometimes you may stage the presentation. This will help you a great deal because during the actual ceremony, things sometimes happen very quickly. Also, some of the presenters have very little "camera sense." Don't let the presenter's hands hide the medal.

Figure 2-12 shows a typical award ceremony photograph. If you have an opportunity to improve on this, do so. You may shoot one standard shot and then use one of your own creative shots. Remember that photography is art, not nuts and bolts; so don't be afraid to improvise.

Trophies and Certificates. Sports trophies, certificates of achievement, letters of appreciation, etc., fall into this category. The standard shot (fig. 2-13) shows the presenter and the recipient holding the trophy or certificate while shaking hands below it. Have them hold the certificate or trophy so that it can be seen. Place the participants close to each other. A normal conversation distance leaves too much dead space between them.

Here, as in medal awards, you need to observe the background. It should be as plain as possible. A cluttered background will distract the viewers' attention.

Have the participants look at the award or each other. Don't let them "mug" the camera.

Again, you may have an idea to improve this standard shot. Don't be afraid to use it.

Promotions. The pose for this shot is usually with the recipient standing beside the supervisor or commander. The commander or supervisor is holding the

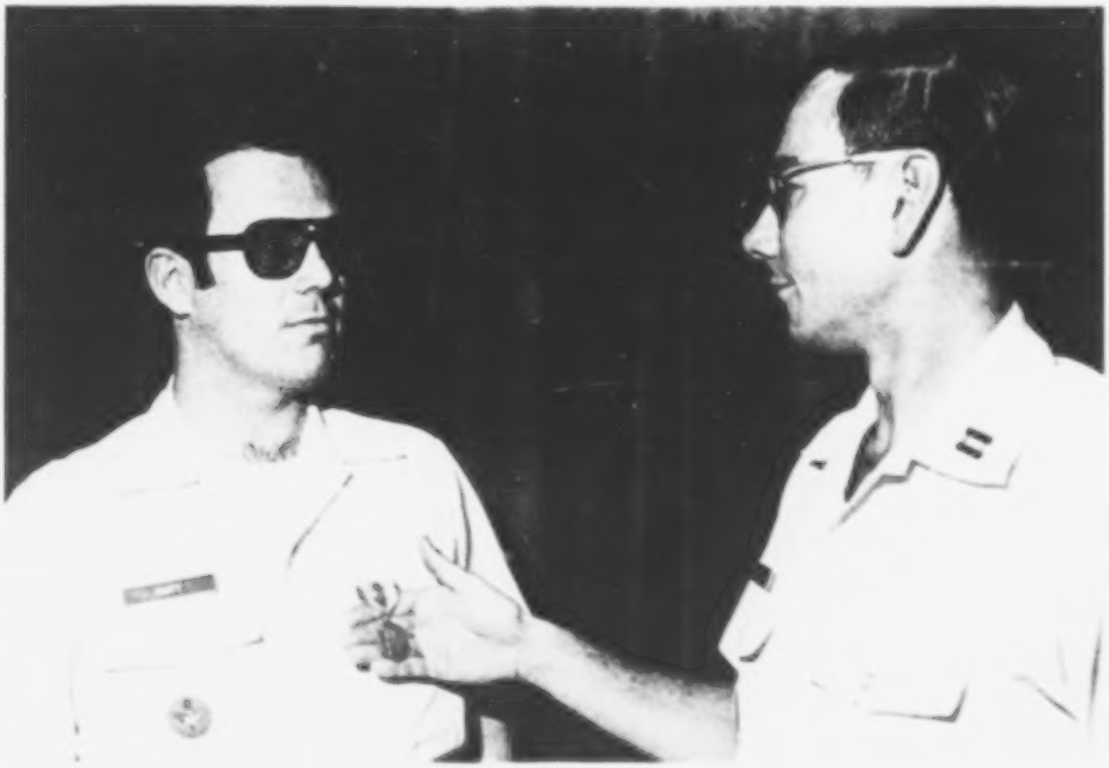


Figure 2-12. An award ceremony.

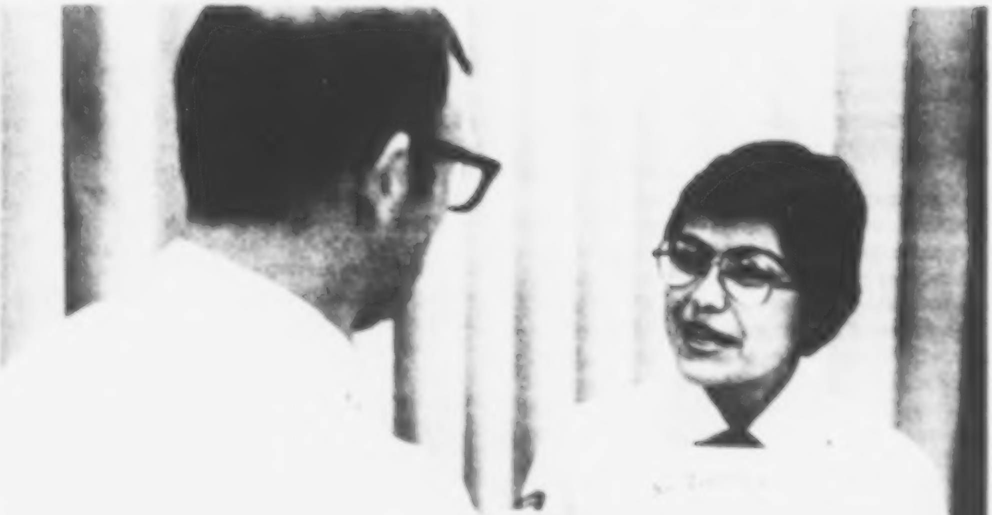


Figure 2-13. Standard certificate photo.

new stripes or insignia next to the old ones. Sometimes you may add the spouse helping with the promotion.

Make sure everyone is smiling, because this is a joyous occasion. Watch the background and the dead space between the participants.

You might snap up this shot using oversized stripes or insignia. You should try to use some imagination to keep these shots from becoming "ho hum" pictures.

Swearing-In Ceremonies. The normal shot for swearing in shows the officer and the reenlistee in front of the ~~[illegible]~~ flag with both participants having their right hand raised. Shoot from an angle that will show the reenlistee. The officer is less important and can be in profile (see fig. 2-14).

This shot can be kept from being ordinary by including the spouse and perhaps the family.

Helpful Hints. The preceding material told about the typical stock poses. They are the poses that are nearly always used. Although these are the standard ways to pose these shots, you should try to come up with imaginative new methods.

These standard shots of the participants holding a certificate, trophy, new stripe, etc., have become known as "grip and grins." Don't become known as the "grip and grin guy." Use your imagination. Come up with something new.

In an effort to evaluate yourself and your photography, you should try to avoid the grip and grin syndrome. Some of the following hints may be helpful to you.

If a person gets an award for doing an outstanding job, take the picture at the job site.

If the shot is a reenlistment, show the enlistee in the job or enjoying the benefits of Air Force life. Get away from two people standing at attention with their hands in the air.

For best mess, best motor pool, Airman of the Quarter, etc., awards, have the individual showing off the job site. You can't tell much from a picture of two people holding a paper and each other's hands.

Do your best work, use your imagination, and don't be afraid to improvise. Someday you may be on the other side of the camera for your own award. Good luck.

Exercises (413):

1. What is the most important element in an award ceremony?

2. Why is it sometimes necessary to stage an award ceremony?

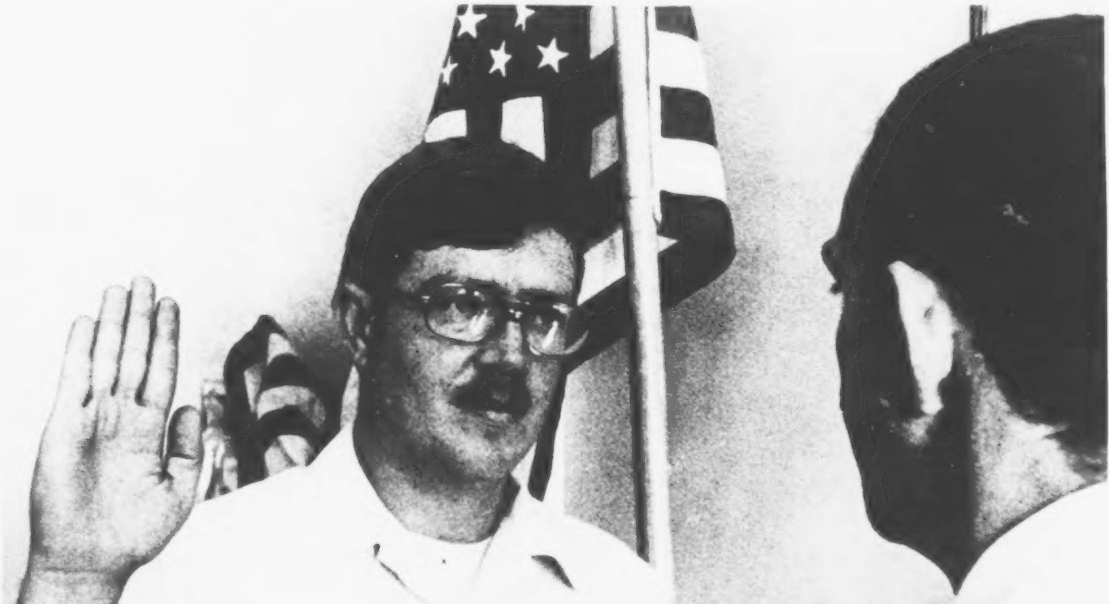


Figure 2-14. Swearing in ceremony.

3. How should you position a certificate or trophy?

4. What type of background should you try to have in any awards ceremony?

5. What is one "trick" you might use to snap up a promotion shot?

6. Who is the most important person in a reenlistment photograph?

7. Give an example of what you could to to snap up an awards and presentation photograph.

2-6. Close-Up Photography

Close-up photography (sometimes called macrophotography) is not a type of subject, but a technique to make large images on film by getting close to the subject. There is no rigid rule as to what constitutes a close-up, but methods that achieve at least a 1:1 or larger image certainly qualify. These image sizes are achieved through the use of special lenses, lens attachments, bellows, extension tubes, and even microscopes. (When microscopes are used it is called microphotography—and often requires specialized techniques.) Close-up photography has wide application in industrial and ~~unsatisfactory report~~ photography.

Material Deficiency Report (MDR)

414. Cite selected techniques and procedures used in close-up photography.

There are a number of techniques and types of equipment that can make close-up photography a valuable tool for you. Let us consider equipment, exposure, and lighting.

Equipment. Close-up photography can be accomplished with a view camera that has a double bellows extension. A double bellow extension increases the distance from the lens to the film to twice the focal length of the lens, thereby producing a 1:1 image. A triple bellows extension is also possible for even greater image sizes. The view camera, therefore, would be ideal for most of your close-up work because of its large negative size and many adjustments.

The only type of small camera that is really suitable for close-up work is the reflex type. Through the use of special equipment, cameras like the Nikon F2, can be put to work. Consider the following attachments:

a. A variety of macro lenses are available that focus very close to the subject and can give 1:1 reproduction.

b. Close-up diopter attachments, which are optical elements that screw into the front of the lens like a filter, give closer than normal focusing capability and thereby permit a larger image.

c. Extension tubes are rigid tubes that mount between the camera body and the lens. Different tubes can be combined to create different effective focal lengths. The longer the focal length the larger the image size.

d. Bellows attachments are available that, like the extension tube, fit between the camera body and the lens. Unlike the extension tube, a bellows permits continuous adjustments through its accordian range, and therefore is more versatile.

e. Telephoto lenses can also be selected whereby the design ("macro" feature) or the use of attachments permits you to focus within a couple of feet or less of the subject. This permits a greater shooting distance than shorter focal length lenses while maintaining a large enough image size. This can be of great advantage in nature photography.

f. There are a variety of microscope attachments which permit the use of the camera body and microscope in combination.

NOTE: Close-up photography requires excellent quality lenses. Any type of distortion or defect will be quite apparent with such large image sizes and close focusing.

Focusing. Sharp focusing is absolutely essential. This is why a reflex camera or a camera with ground glass focusing is a must. A rangefinder camera suffers from parallax at close focusing distances. Another aspect is depth of field. Due to the short lens-to-subject distance, and often long effective focal lengths, depth of field is very limited for any given aperture. Therefore, no focusing error is permitted.

Film. Choice of film is important. The fine-grain, high-contrast films that can record maximum detail are probably the best choice, but their slow speed can cause problems. Faster films may not have the contrast or resolving power, but they permit a wider choice of apertures.

Tripod. The camera must be rigidly supported since any vibration will result in a soft image.

NOTE: The subject must also be still. If the subject cannot be held still, such as with a flower or a bird, a higher shutter speed must be used with a consequently larger aperture.

Exposures. Exposure in close-up photography requires test and experience unless your camera is equipped with a behind-the-lens light meter. Reflected readings are difficult to make because the area being photographed is so small. A gray card, however, can be used as a substitute for the subject. Incident light readings often prove easier to take.

However, the basic problem is that the effective focal length usually has been changed through the use of accessories so that the calibrated apertures of the lens are not effective. For example by doubling the focal length of a lens through the use of a bellows, the indicated f/stop becomes one-fourth as effective. This means that if the aperture is set at f/8, its actual effect is as if it were set at f/16.

You can work out the proper exposure increase that is necessary if you know the scale of reproduction. Take the scale, add 1 to it, and then square the result. The resulting equation is $EF = (M + 1)^2$. For example, for a 4 times magnification (4:1), the factor would be $(4 + 1)^2 = 25$. Exposure would therefore have to be increased 25 times over the exposure reading.

NOTE: A big advantage of those cameras that have behind-the-lens metering systems is that such an exposure calculation as above is unnecessary. The meter will measure the decreasing amount of light as the bellows is extended or attachments are added.

Lighting. Lighting is essential to good photography and critical in close-up work. The problem is that very little light is being reflected by a subject which is small. Daylight is normally not bright enough, but you can increase its effect through surrounding the subject with reflectors that can increase the overall lighting level on the subject. Most close-up work is therefore done with artificial light like photofloods and strobes. Such lights become more useful with the attachment of a barn door or snout to direct the light. The best type of light of all is a ring light (circular electronic flash that fits around the camera lens), which produces very even illumination.

Once you have determined a method to get enough light on the subject for a satisfactory exposure, you should carefully consider lighting direction and ratio. Front lighting with a low lighting ratio is the safest kind and is essential where maximum detail is necessary. For more dramatic shots, side lighting (great for showing textures), cross-lighting, or even backlighting (for example—photographing a spider web) can give you interesting results.

NOTE: Special lighting may be necessary for glassware or other highly reflective subjects. Try bounce lighting, use of a diffuser, or light tent. (A light tent is a tent made of translucent material with a hole in it. Lights surround the tent to cast even illumination on the subject. The camera lens is stuck through the hole to photograph the subject.)

Composition. Composition is as important in close-up photography as in any other type. The large image size is helpful in achieving simplicity. You should consider carefully its image placement. The background should be plain and simple. Different colored posterboards are best for this. Filters can be used to achieve the proper tone or color that is required.

Exercises (414):

1. A double bellows extension will produce what size image?

2. What is the difference between an extension tube and a bellows?

3. Why is there limited depth of field when doing close-up work?

4. Why must you use a tripod when doing close-up work?

5. How much exposure increase is necessary if you are making an 8X enlargement?

6. Why is a ring light an effective lighting tool?

2-7. Materiel Deficiency Reporting

If you bought a tire for your car and later discovered it had a blemish in it, you would just drive back to the dealer and get it taken care of. But suppose something was wrong with the engine that only the factory could fix. You probably couldn't drive to Detroit to have it checked out. You would send them some pictures of the defective part. Then they could tell you how to get your engine fixed.

The Air Force sometimes has the same problems. A piece of equipment may be defective, but it can't be sent back to the manufacturer. So pictures are used. This is where you beome involved. You are the photographer and will have to take some pictures.

The Air Force calls this a Materiel Deficiency Report. The procedures are covered in TO 00-35D-54, *USAF Materiel Deficiency Reporting and Investigating System.*

415. Cite selected photographic procedures and techniques used in materiel deficiency report photography.

General Planning. To accomplish good MDR photography, you will need the proper equipment and materials. When planning your equipment list, get as much information as possible concerning the MDR project. Find out from the requesting agency whether or not the equipment to be photographed can be brought to the laboratory. This is especially important when small objects are to be photographed, since it allows you a greater choice of equipment, background material, and lighting.

If the item is located outdoors, select the appropriate equipment and supplies. You should ask yourself the following questions regardless of where the job is to be done:

a. How much film is needed? What format? Is slow or fast film required? (You will want to use the finest grain film that you can under the circumstances.)

b. Which type of lighting should be used—available or artificial? Which will give the best results? (You will want as even lighting as possible.)

c. Is it necessary that I take along a tripod? (A tripod us usually essential to insure steadiness.)

d. Is the subject bright or dark? Is it highly reflective? Is texture important? These factors will affect the choice or the direction of your lighting.

Camera Choice. Always use a camera having the largest possible format that you can. This will insure the best possible enlargements. The 4 x 5 view camera is probably best suited for the majority of MDR work. This is particularly true because adjustments for perspective may be required. Where a view camera is not possible, then a press camera would be the next choice. The 35-mm cameras are rarely suitable for this type of work because of the small negative that is produced.

NOTE: A copy camera is often suitable where the object is small and therefore can be brought to the lab and mounted on the copyboard. For example, a copy camera is ideal to shoot circuit boards.

Lenses. You should have a variety of lenses available so that you can get the necessary image size for the shooting distance. You should also think about the necessity for both overall and close-up shots.

Preparation of the Defective Equipment. You may need extensive assistance from technicians familiar with the malfunctioning or deficient equipment. Because of the time required for preparation of the defective item for MDR photographs, you should be ready to perform your mission.

It is often advisable to include a piece of chalk and a black grease pencil with your equipment. The chalk is useful in making cracks stand out on a black surface; likewise, a black grease pencil may be helpful in making a crack stand out on a light surface. Common putty or talcum powder can be used to tone down the gloss on highly polished surfaces. If the photograph is to be taken outside the laboratory, try to foresee problems that may occur. A little foresight may eliminate the need for returning to the lab for a small, relatively insignificant item of equipment.

Lighting. Whenever possible, avoid using single-lamp lighting. It tends to give high-contrast photographs that lack adequate detail in the shadows. Normally, you get the best lighting by using two or more floods. You will find that lighting the subject is the key to top results. The lighting must be even so that there is full detail. This may provide quite a challenge in location shooting where the defective part may be in quite a "dingy" spot.

Adequate Coverage. To insure adequate photographic coverage of the defective equipment, work closely with the technicians who normally use the equipment. Make several photographs. First, take a photograph from sufficient distance to indicate what the item is. Then move in toward the defect, showing enough of the surrounding parts of the subject so that those viewing the photograph can tell immediately where the defective part is located with respect to the total equipment. Finally, take at least one close-up of the actual defect, showing the problem area in detail. Change camera angles as necessary to portray the defective component and the specific defect clearly. It is better to take too many shots than not provide enough coverage. (See figs. 2-15 through 2-17 for typical MDR coverage.)

Preparation of the Submission Photographs. An improperly prepared photograph is of little value to the person who must investigate the unsatisfactory report. The following paragraph, quoted from TO 00-35D-54, is noteworthy.

> Each photograph will be marked on the face with identifying and orienting lines, such as aircraft, missile or space vehicle, TMS and serial number, and station numbers and locations so that the exact location and nature of the reported condition is clearly shown. When possible, these markings will be placed on the affected part or adjacent structure prior to photographing . . . .

Remember, the main reason for forwarding photographs is to avoid shipping the actual equipment. Since the equipment is not available to the investigators, the photographs must be just as good as having the actual equipment. Clarity of detail is essential; coverage must be complete.

Photograph size considerations. There are no specifications as to the exact size for the MDR photograph. A good rule to follow is to keep the size as small as possible, yet show the necessary detail and information.

Since the transmission of the photographs is through the mail, the preferred size is 8 by 10 inches (20 x 25cm) or less; but if it is necessary to submit larger photographs, they should be protected against damage. Sheets of cardboard or mailing tubes are generally sufficient protection.

Print and negative quantities. We quote TO 00-35D-54 again to learn the number of prints to be made: "Three prints of each photograph or one duplicate negative will be forwarded . . . ."

Exercises (415):

1. What is the advantage of bringing the defective material to the laboratory?

2. What speed of film should you use?

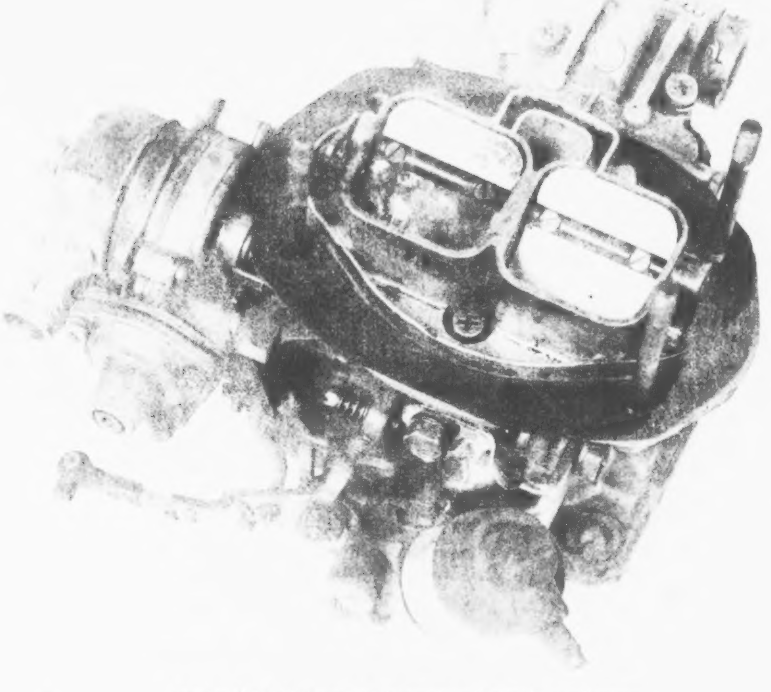


Figure 2-15. Deficiency photo showing main equipment.

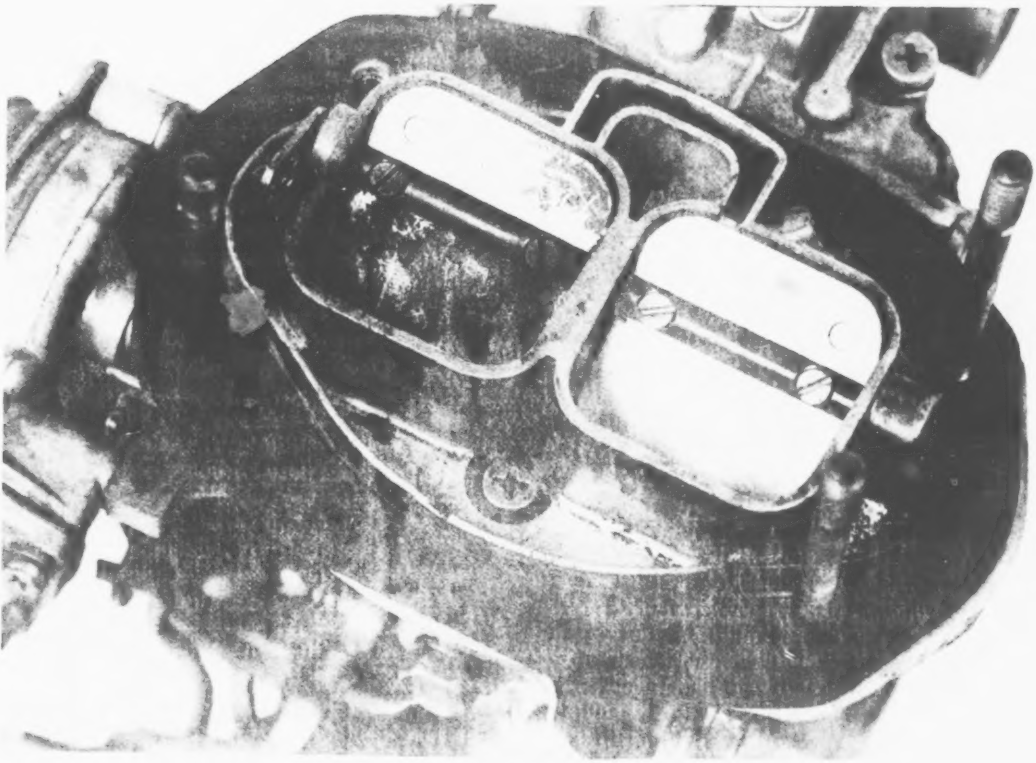


Figure 2-16. Deficiency photo showing relationship to main equipment.

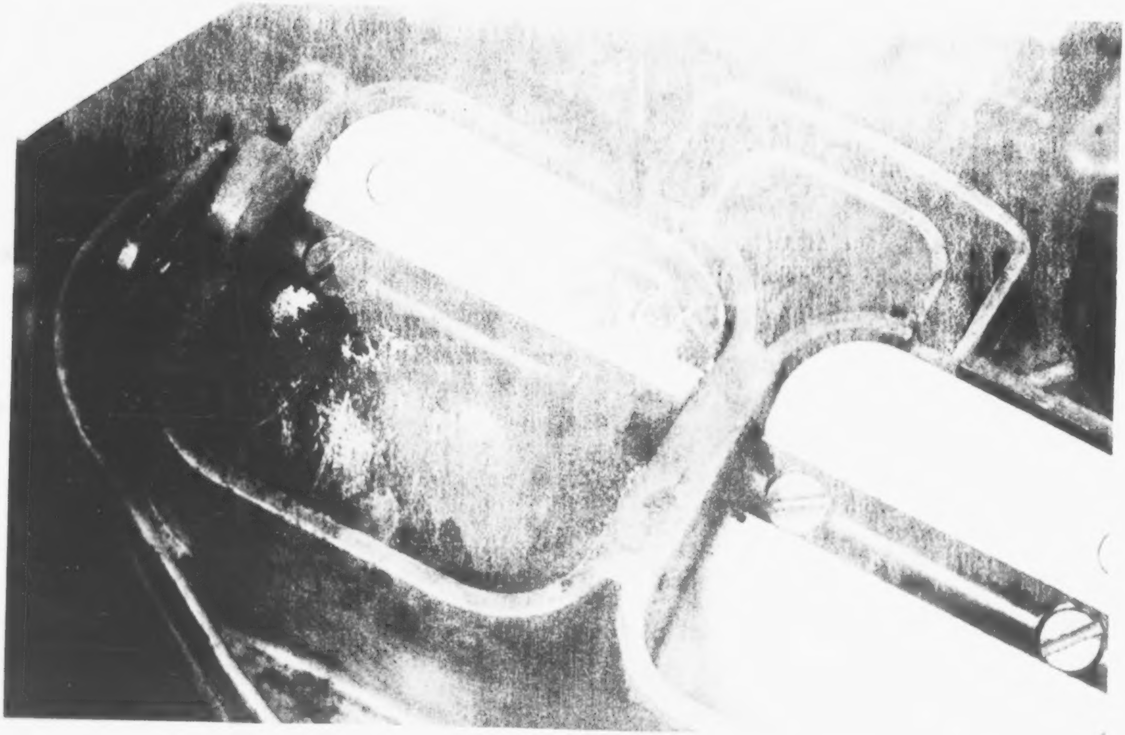


Figure 2-17. Deficiency photo showing defect in detail.

3. What type of camera is ideal for photographing a circuit board?

4. How might you use chalk when you are shooting an MDR?

5. What type of lighting is generally needed in MDR photography?

6. What TO should you consult to guide you in your MDR work?

2-8. Architectural Photography

The daily routine of photographing many commonplace subjects can become a methodical and uninteresting task. In the process of making pictures "just for the record" and frequently shooting the same scene week after week, you may acquire the habit of neglecting the basic elements of good composition when setting up the camera. Actually, among the commonplace subjects all around us, there are many scenes that make interesting photographs if we take the time to compose them carefully.

When photographing construction work or a building being remodeled, there is no particular interest in graceful lines leading to the subject or billowy clouds in the background. The proper balance of tones and objects is of secondary importance. As an Air Force photographer, you are concerned with the *purpose* of the picture; that is, you strive to record all of the essential detail as clearly and accurately as possible, avoiding any distortion or exaggeration.

In this section we will cover some of the techniques and principles of architectural photography.

416. Cite principles, techniques, and procedures necessary to accomplish architectural photography.

Preparation. You can do a better job on any assignment if you take time to study it beforehand and make your plans and preparations accordingly. Determine the camera angle, the size and type of camera, the focal length of the lens, the time of day, and light conditions best suited for photographing the subject. It is little [illegible] how much better a subject

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appears when photographed with the proper lighting. Then, if you pay attention to the factors of good composition, it is relatively easy to produce good, interesting pictures.

Film. Use a film with a moderately fast emulsion for this type of assignment. Because architectural subjects often contain many different contrast areas, the use of a high-contrast emulsion is not recommended. On the other hand, as textures must be photographed with a great deal of clarity and good tonal separation, the very soft portrait-type films may not produce the desired results.

Cameras. To photograph the wide variety of architectural subjects, you need a camera that is portable and that can be used both indoors and in the field. It should have a long bellows extension, vertical and horizontal swing adjustments on the back, front movements of tilt, rising front, and lateral shift; and it should be equipped with both long and short focal length lenses. Since the view camera contains all of these features, it is probably the most suitable camera for this type of work.

Filters. In black-and-white photography, do not overlook the use of filters to change the lighting at any given time of day. True, you cannot alter the lighting radically through the use of filters, but often you can make worthwhile improvements. In photographing architectural exteriors, the blue sky is usually the background. By selecting the proper filter, you can make the sky lighter or darker than it usually is when panchromatic film is used without a filter.

Outdoor Lighting. From a basic lighting standpoint, photographing the exterior of a building is similar to making a portrait indoors. In both cases, the main illumination must fall on the most important plane of the subject, its face.

For general architectural photography, there is a standard approach to lighting of buildings that is usually satisfactory. The first thing to do is to select your location. A word of warning: always shoot a building so that you include part of one of its sides to show the depth of the building. In a head-on shot the building might consist of a single flat wall of bricks, or blocks, as far as anyone could tell from the picture.

Basically, there are two types of lighting that you should avoid in architectural exterior work. One is the totally flat lighting you get on an overcast day. The other is sunlight that comes from directly behind you. Direct sunlighting is flat only if it comes from the wrong direction, such as from behind you.

The best time of day to take each picture is probably different for every building. Also, different parts of the same building exterior are best photographed at different times of the day. If the lighting is not exactly right the first time you see the building to be photographed, don't be surprised; it usually is not. If there is no hurry about taking the picture, the thing to do is to observe very carefully the lighting effects at various times during the day. Once you have found the best lighting for a particular building, the rest is easy.

Interior Lighting. Quite often, you can make photographs of interiors using the normal lighting within the area. Many interior areas are well enough illuminated to produce high-quality photographs when you use relatively short exposures. But under existing light conditions, a tripod is usually necessary. There are times when you need to use floodlights, either to supplement the interior lighting or to provide the total lighting for the area.

Flash can be used for illuminating interiors, but you will find that to get high-quality flash illumination, you need considerable skill, especially when shooting a very large interior. Occasionally, when the interior is well-constructed and painted, bounce-light from a flash source can be used. Instead of directing light at the area being photographed, it is directed at the ceiling or at the wall behind the camera. When you use bounce-light, you will find it much easier to produce an even, overall illumination. It should be noted here that if difficulty is encountered in obtaining an even illumination, the bounce-light technique can also be used along with other types of illumination, such as floodlights.

Under certain conditions, interiors can be photographed very well by the "painting" technique.

When photographing an interior, always be sure to observe the lighting effects created by windows and/or doors that open to the outside. For the best balance, light coming in from the outside must be equal to or less than the light inside of the room. If you neglect to check this, you may find that doors and windows produce so much exposure in their respective areas of the negative that it is impossible to obtain a satisfactory print. Regardless of the corrective techniques used in printing the negative, these overexposed areas will print too light. When it is impossible to overcome brilliant exterior lighting conditions, you may need to make the interior photograph at night.

Painting with light. The technique called painting with light is essential to every photographer. As the term implies, light is painted on the subject by moving the lamp continually over every area of the scene. This is done throughout the duration of a very long exposure. Since light is painted over the subject while the exposure is being made, painting is suitable only when exposures are long.

To use the painting technique, open the shutter, move the light over the subject until you obtain the desired total illumination, and then close the shutter. The intensity of the lamp in any given position during the painting procedure is controlled by the lamp-to-subject distance. By moving close to the subject, the area illuminated can be lightened in the print; by moving away, it can be darkened.

Many times, the painting technique (just as is the bounce-light technique) is used in combination with other lighting. In this way, you can give extra exposure to any special portion of the photograph. Painting with light is especially helpful when you must photograph a large object or a large area. Also, when details within the shadow areas are important, this light can be used effectively. The following considerations are necessary to [illegible] painting with light:

- The exposure must be [illegible] the light to be moved [illegible] lighting.
- The light must be kept in constant motion during the entire period of the exposure, or uneven illumination will result.
- If only the painting light is to be used to produce the exposure, all other illumination should be completely excluded.
- If the photographer must enter the field of view of the lens, he must keep in constant motion during the entire exposure.

When you photograph extremely large areas, you can open the shutter, walk around the entire area, painting light on the various surfaces, and then return to the camera and close the shutter. Such an exposure might take many minutes, but if you are careful not to [illegible] yourself and if you are in continuous motion, your image will never be seen in the finished photo. Painting with light is best accomplished using a reflector light unit to direct the light where you want it. The reflector should be deep enough to keep the lamp from shining into the lens. When painting with light, remember that just like applying paint, the light must be spread evenly over the surface. Total exposure is a function of the intensity of the light multiplied by the length of the time the light is allowed to fall on the area illuminated. Too much time or too much intensity can create overexposure. Experience is about the only teacher for the use of this technique.

Camera Operation. As we said earlier, the view camera (fig. 2-18) is the best choice for architectural photography. The reasons are wrapped up in its adjustments. Their functions are discussed in the following paragraphs.

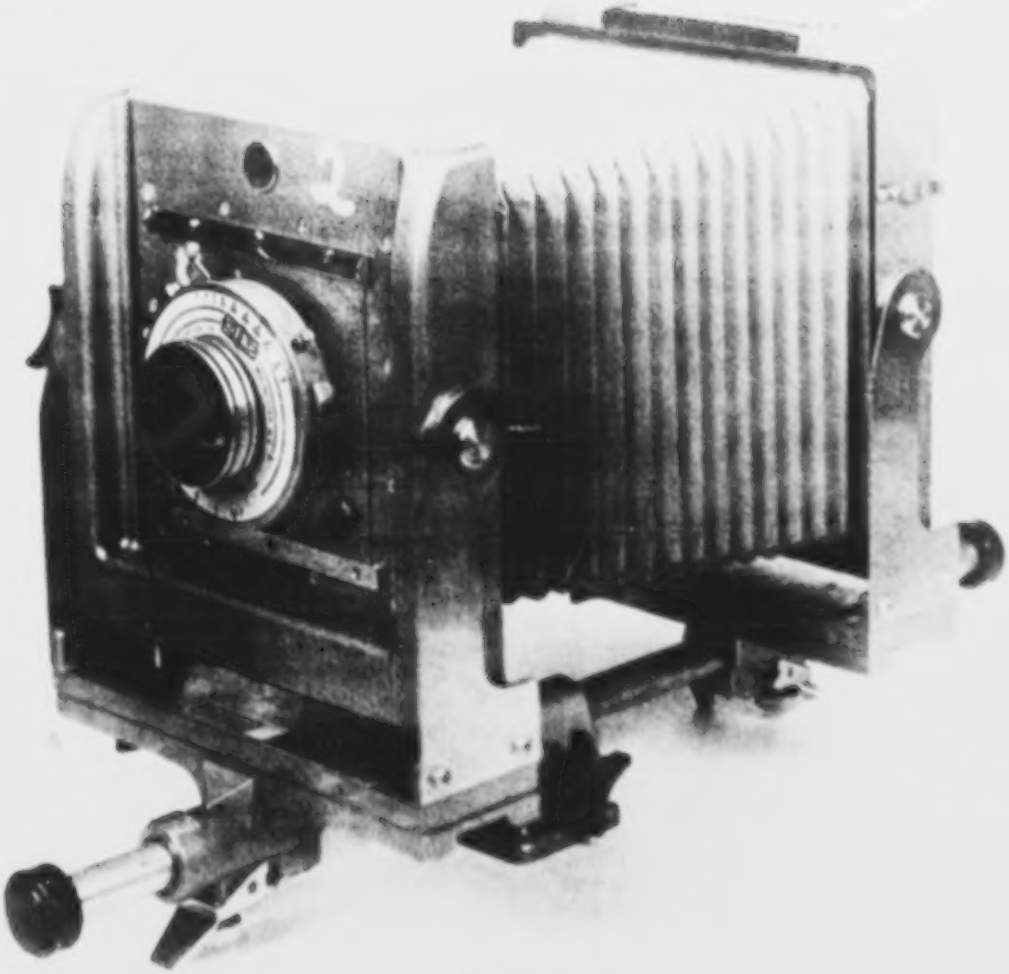

Figure 2-18. A view camera.

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Rising front. The rising front allows the lens to be raised in relation to the center of the negative, thus extending the effective angle of view in a vertical direction. It permits bringing more of the height of the object into the field without fear of distortion obtained when the camera is merely tilted upward. This adjustment is limited by the physical construction of the camera and the covering ability of the lens.

Falling front. The falling front permits the lowering of the lens in relation to the center of the negative. The function and principle of operation are similar to those of the rising front.

Sliding front. The sliding front allows the horizontal displacement of the lens in relation to the center of the negative. Its principles of operation and function are similar to those of the rising and falling fronts.

Vertical swing front. This view camera control is used the change the plane of focus of the lens when photographing tall objects. This is necessary because the distance from the top of a tall object, such as a building, to the camera is obviously greater than the distance from the bottom of the object to the camera. Tilting the camera lens to its axis does not alter image shape on the groundglass; only image focus is changed. The vertical swing front is most often used in conjunction with the vertical swing back.

Horizontal swing front. This control serves the same function as the vertical swing front, except that it is used on the horizontal plane such as when photographing long objects at an oblique angle. It is most often used in conjunction with the horizontal swing back. When using either the vertical or horizontal swing front, you should remember that these adjustments are limited by the usable circle of illumination of the lens.

Vertical swing back. This is perhaps the most important adjustment and the one used most in architectural photography. It is employed to preserve parallel relationship of the camera back to the subject plane, and sometimes to compensate for focal differences of the subject plane (without considering parallelism). If a subject is too tall to be included in the field of view, even when the rising front is used, the camera is tilted upward and the camera back swung into vertical position, parallel with the subject. There is a discrepancy of focus, as the lens axis is still parallel with the camera bed, but this may be compensated for by stopping down or tilting the lens.

Horizontal swing back. This adjustment is identical in action with the vertical swing back, except that it controls horizontal parallelism or horizontal focal differences. Its use in architectural work is largely confined to correcting exaggerated perspective when the camera is turned at an angle to the subject. When the sliding front is insufficient and the camera must be turned to the right or left to include a greater area of the subject, the horizontal swing back retains the parallel horizontal relationships. Of course, horizontal perspective is not as troublesome as vertical perspective. In cases where angular views of buildings are concerned, no horizontal linear corrections are required. In such cases, the horizontal swing back is most useful in compensating focal differences.

Back focusing. On most standard view cameras, both the front and back assemblies are movable on the camera bed, and focusing may be done with either of them. In working close, the back focusing is most helpful, since image size may be controlled by carefully setting the distance of the camera back from the subject, then correcting the focus with the front assembly. If only front focusing is available, the entire camera must be moved forward or backward to make small adjustments in the size of the image. Back focusing gives opportunity for most careful scaling of the image.

All camera adjustments have little meaning unless the camera is first set up in the ideal position—that is, level in both vertical and horizontal directions, with the axis of the lens centered on the film plane and with all adjustments set at "neutral" and checked for alignment. As the composition is developed on the groundglass, certain adjustments become necessary. Never make any camera adjustment except when it truly is required. All deviations from normal in the position of the lens in relation to the negative depreciates the quality of the optical image.

Use of the view camera will be less confusing if you remember these three rules:

(1) Rising, falling, and sliding movements are used to control the position of the image on the film plane.

(2) Vertical tilt and horizontal swing of the camera *back* are used to control the *shape* of the image on the film plane.

(3) Vertical and horizontal swing of the camera *front* are used to control the *focus* of the image on the film plane.

Exercises (416):

1. From the following statements about architectural photography, identify which ones are true:
   a. You should use a high-contrast film for all architectural photography.
   b. A 35-mm camera is the best camera for architectural photography.
   c. Shoot a shot of a building to include two sides.
   d. You should avoid totally flat lighting.
   e. Flash illumination can produce acceptable results for interior lighting.
   f. When you shoot inside a house, open all the blinds and doors to give even lighting.
   g. When painting with light, you should keep your light in constant motion.
   h. The front adjustments of a view camera control the focus.

2. What are the requirements of a camera to be used for architectural photography?

3. What are the two types of lighting you should avoid in exterior architectural photography?

4. What kind of exposures must you use if you are going to paint with light?

5. Cite the three rules of view camera operation.

2-9. Investigative Photography

Investigative photography is just that; it is not an editorial nor an essay. It must be factual, straightforward photography. If done properly, it will be very valuable to the investigative agency.

In this section, we include as investigative photography, aircraft and ground accidents and legal and criminal types of photography.

417. Specify techniques used for adequate coverage of aircraft and ground accidents.

Purpose and Scope of Investigative Photography. The objective of crash and accident photography is to provide good quality photographs to help investigating personnel determine the cause of the accident or crash. For example, in the case of vehicle accidents, the photographs may supply vital information by showing skid marks, point of impact, road conditions, and environment that may indicate the cause of the accident. Some of the things accident photographs can indicate are:

- Carelessness in the operation of a vehicle.
- Loss of control due to speed or a defective mechanism.
- Inadequate control due to physical disability of the operator, perhaps because of illness, intoxication, or drugs.

These same photographs may also be used as evidence in a military court of law.

Photographs of aircraft accidents become an integral part of the investigation. Such photographs serve a dual purpose. First, they help the investigators to graphically reconstruct the events of the crash; second, they provide a means of identification of parts of the aircraft. The distribution of parts in relation to the crash site and the initial point of impact can help indicate what happened during the crash.

Often these photographs are shot in color to show the extent of heat or chemical damage. The use of color also allows the investigating team to determine other factors not easily recognizable in black-and-white photographs. For example, suppose that an internal explosion during flight caused an aircraft to crash. An analysis of the black-and-white photographs reveals that the explosion was caused by the malfunction of a small moving part in the engine. If color film were used, additional facts may be brought to light. For instance, excessive friction on the moving parts leaves a color pattern. A photograph of this part in color would tell the investigators the degree of wear and the temperature caused by the friction.

Emotional Stability. Crash and accident photography requires an emotionally stable photographer. It may be necessary for him to observe other persons suffering from severe wounds, fractures, burns, mutilation, or shock. Additionally, some of the injuries may be sufficiently severe to cause death. Conditions as mentioned, plus the confusion and excitement that normally accompany a severe accident, may cause nausea or even fainting. It is important that the photographer be able to go about his work objectively just as he would if he were covering any other subject. He must not add to the problem already existing. In addition, he must be able to think about the photographic problems involved. He must be calm under the very serious conditions which he may encounter.

Seeking Assistance. If possible, try to find out before you leave exactly to whom you should report when you arrive at the scene. If absolutely necessary, obtain either advice or assistance from the person in charge of the situation. This could be a person representing any of the following career areas: safety, fire protection, security police, investigations, medical, aircrew protection, or the senior officer at the scene. Whatever you do, do not interfere with personnel performing essential duties related to the emergency.

Release of Information. Under no conditions do you have the right to release any information—either verbal or photographic—to activities outside the normal Air Force channels. You must learn that what you photograph is the property of the Air Force. Release information only to the proper authorities, or their representatives, who are charged by the Air Force with a need-to-know.

Mission Planning. Almost every base photo lab has someone available to take crash and accident photographs on a 24-hour, 7-days-a-week basis. This person is known as the "Alert Photographer." Also, almost every photo lab has a particular camera to be used specifically for crash and accident photography and it is usually referred to as an "Alert Camera." If a call is received, all that is necessary is for a photographer to pick up this equipment and report to the scene.

The alert camera kit should be prepared beforehand and should contain film holders or film packs and adapters, flash equipment and such other material as may be needed to insure complete coverage of the mission. It is important that the camera case be carefully checked for necessary supplies and equipment for proper operation.

Lighting. A major problem related to crash and accident photography is the danger of igniting inflammable vapors or fumes with your photographic lighting equipment. Flash bulbs and to a more limited degree electronic flash are both potential fire hazards. Before photographing any crash or accident, be sure there is no danger of starting a fire. If possible, check with the top officials in charge of the firefighting or rescue operation before making your photographs. It may be necessary to use available light (the light from vehicle headlights, etc.) or special safety lighting equipment to avoid endangering the lives of personnel present at the crash or accident scene.

What to Photograph. The photographic coverage needed when a crash or an accident occurs may vary depending on the desires of the investigators. The minimum coverage should include at least the following general coverage: (1) general views of the areas involved, (2) close-up photographs to show important details, (3) photographs of specific parts that might have been the cause of the accident, (4) marks left on the ground that might provide support information, and (5) views that show damage to property—either Air Force or privately owned—resulting from the accident. (See figs. 2-19 through 2-22 for typical accident coverage.)

It is better for the photographic coverage of an accident or a crash to be too complete than not to be complete enough. Extra photographs can always be discarded if they are not wanted; but once the wreckage has been cleared away, it may be impossible to get the desired photographic coverage.

NOTE: The best way to learn the necessary skills of covering an accident or crash is to go out on a few missions with an experienced photographer.

Mission Data Recording. It has been stated earlier that the methods of recording mission data would vary from mission to mission and no specific rules can be applied. Some photo labs specify the minimum data to be recorded when photographing a crash or accident. This data is used to identify negatives and prints, to support various reports, or as evidence in court should a lawsuit result.

If you are assigned to a photo lab where there are no specific rules on mission data recording, the following recommendations can be used as a guide. You should record any information that might be needed. Minimum mission data should include:

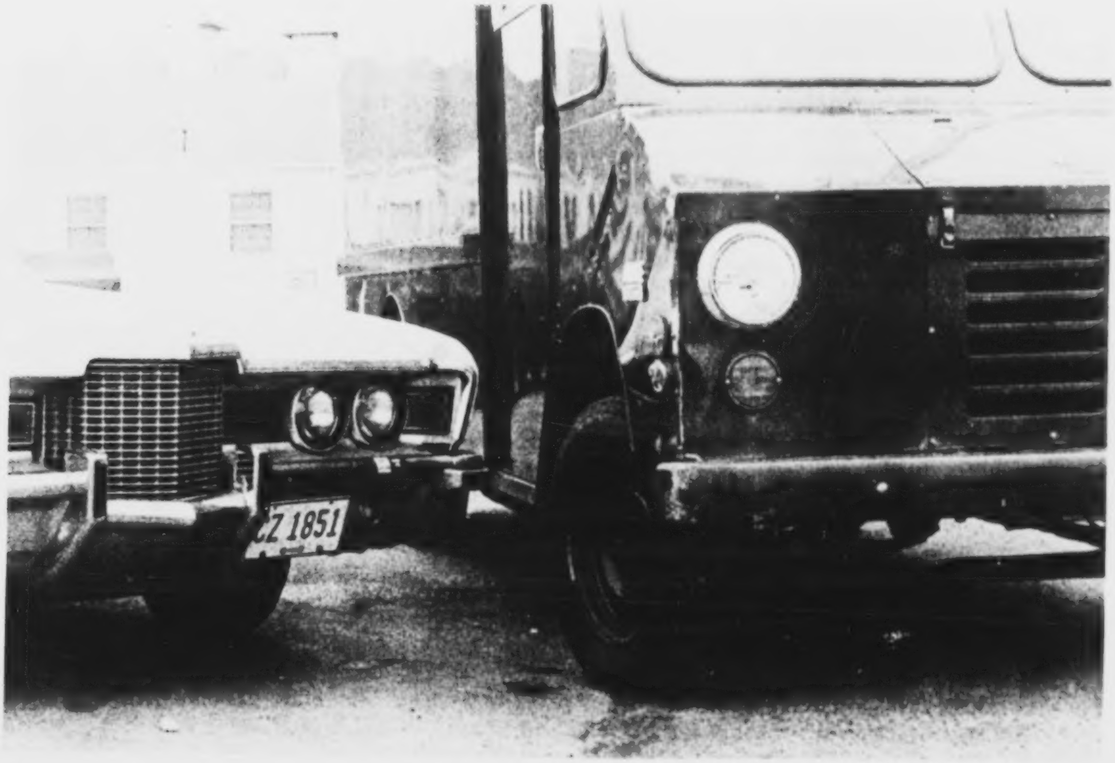

Figure 2-19. General view of vehicle accident.

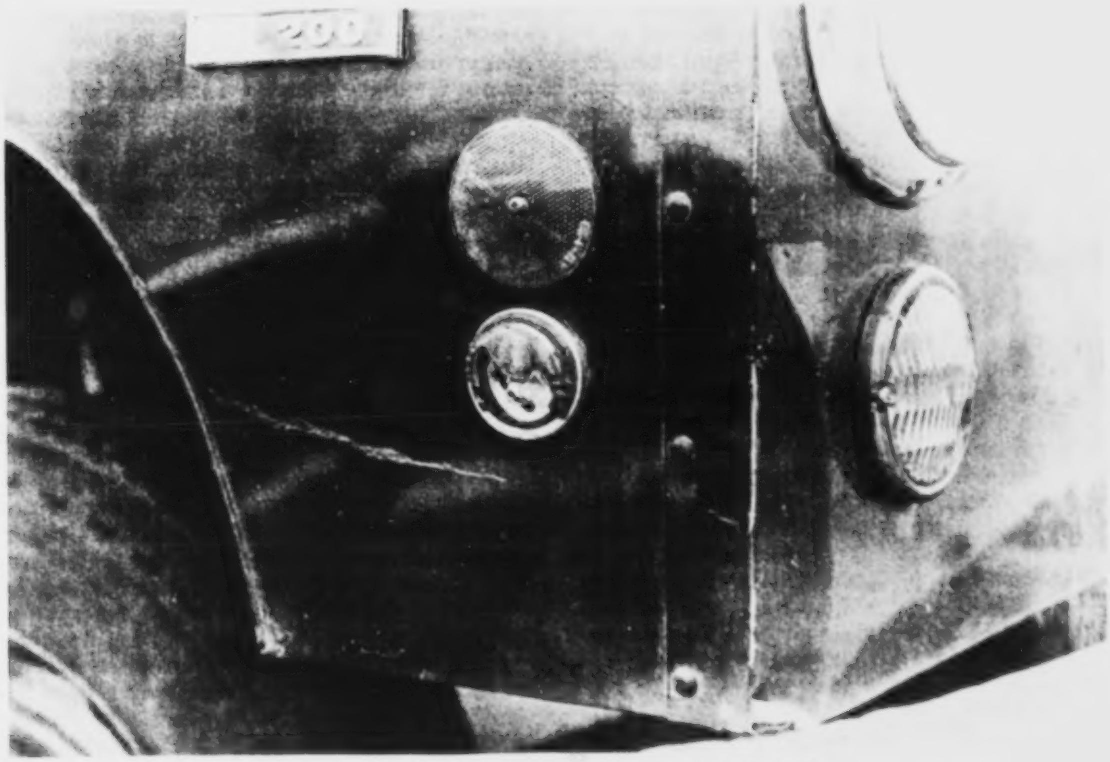

Figure 2-20. Vehicle accident showing damage to first vehicle.

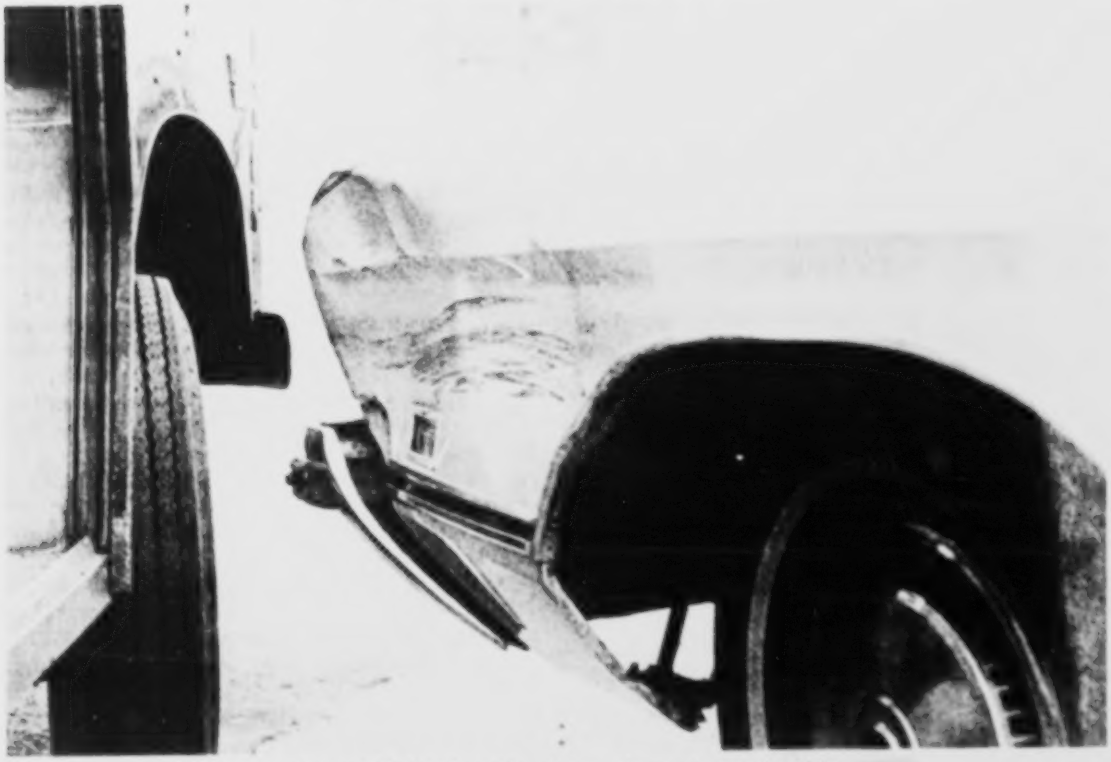

Figure 2-21. Vehicle accident showing damage to second vehicle.

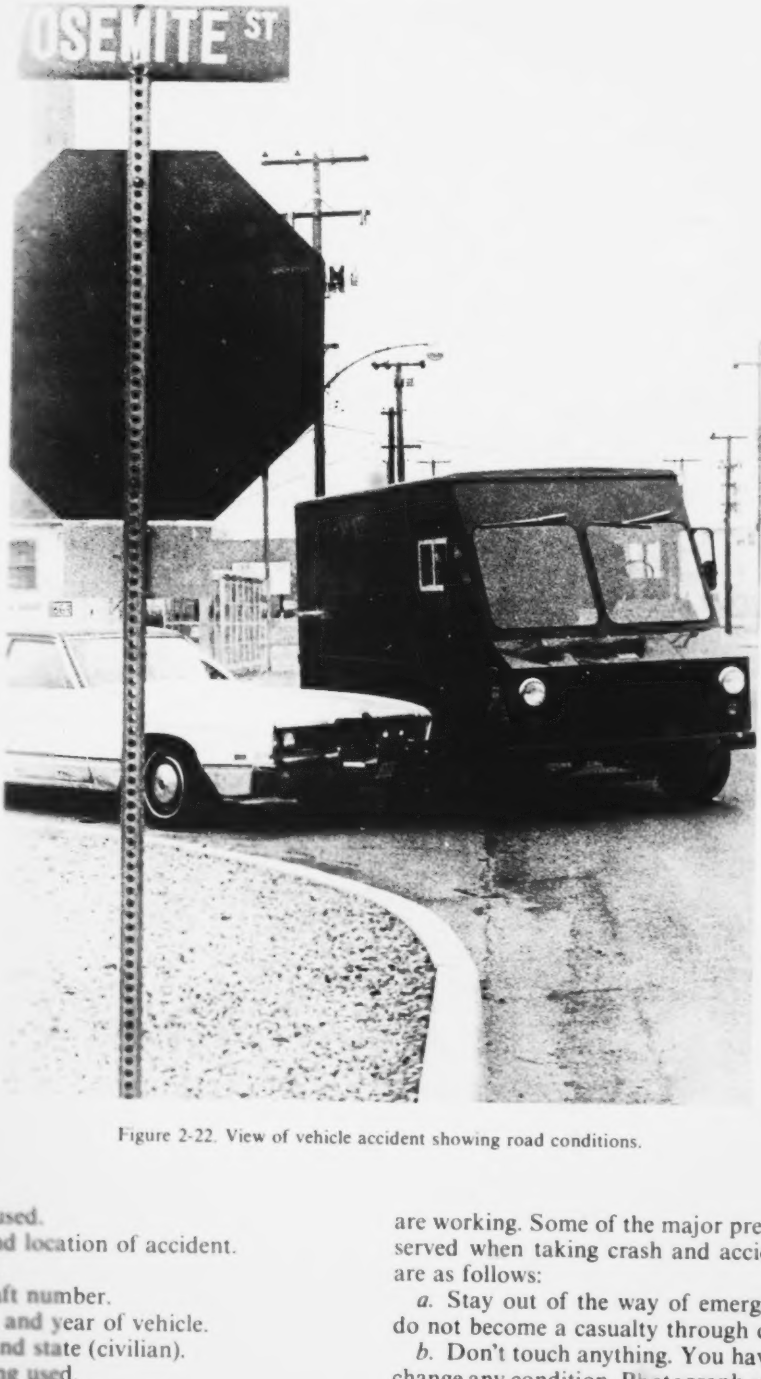

Figure 2-22. View of vehicle accident showing road conditions.

- *a.* Type of film used.
- *b.* Date, time, and location of accident.
- *c.* Classification.
- *d.* Vehicle, aircraft number.
- *e.* Make, model, and year of vehicle.
- *f.* Tag number and state (civilian).
- *g.* Type of lighting used.
- *h.* Weather conditions.
- *i.* Name of individuals involved.
- *j.* Persons with whom you dealt.

Safety. Observe the general, mechanical, electrical, and ground-safety precautions that apply to the type of equipment you are using and to the area in which you are working. Some of the major precautions to be observed when taking crash and accident photographs are as follows:

a. Stay out of the way of emergency vehicles and do not become a casualty through carelessness.

b. Don't touch anything. You have no authority to change any condition. Photograph objects as they are.

c. Exercise necessary precautions when working in or around flammable substances or conditions.

d. Stay alert and be ready for any unforeseen emergency that may develop while you are taking photographs.

e. Be sure that you are aware of the policies relative to photographing items of equipment that are classified.

f. Do not blind the drivers of approaching cars by flashing flash equipment in their direction.

Exercises (417):

1. What is the purpose of photographing an accident or crash?

2. What is the advantage of color coverage of an accident?

3. Why must an alert photographer be emotionally stable during an accident?

4. To whom should an alert photographer release crash information?

5. What problem is there in using flash during an accident?

6. List five areas of general coverage that should be taken at an accident.

7. What type of mission data is recorded in regard to a civilian automobile involved in an accident?

418. Given hypothetical legal/criminal photo situations, determine if the proper techniques were used to photograph them.

Legal/Criminal Photos. Photography is the only procedure that can be used to preserve history factually without any bias. Had there been a photographer around when George Washington crossed the river, we would know for sure if he really stood up in that boat.

Photographs are used in legal and criminal investigations because they show what is there. They can be biased but not if you shoot them properly. This section deals with the methods you must use to show the scene or the evidence honestly and factually.

Uses. There are several ways in which your legal/criminal photos are used. Among the uses are:

- Evidence. Photos are used to record crime scenes, traffic accidents, homicides, fires, objects of evidence, fingerprints, etc.
- Action of offenders. Photos can be used in surveillance of suspects, burglar traps, to record confessions, in re-enactment of a crime, and to record the testing of a person suspected of being intoxicated.
- Court exhibits. In a court, your photos may be used as enlargements, single photos, slides, and as actual evidence.
- Prevention. Photos are sometimes used in crime and fire prevention lectures and in safety briefings.

Procedures. There are certain established procedures you should follow when shooting a legal/criminal assignment. Since there are so many different situations you could get into, we will cover only those most frequently encountered:

a. Identification. You may be called on to photograph a suspect or even the convicted person. If you need to photograph such a person, do it in a factual manner. Do not worry about flattering lighting or posing. Show every freckle, mole, or blemish which might aid in identifying the subject. A head-and-shoulders composition with front, flat lighting will do this effectively.

b. Crime scene. In crime scene photography, particularly those of a violent nature, the scene must be shown clearly. The location of the scene and the objects in it are of vital importance. Your first step should be to photograph the entire scene. You must then get complete and accurate photos of all the aspects of the scene before any objects of evidence are removed or disturbed (including bodies).

Do not move or touch anything yourself. If the lighting or position of an object is poor, do the best you can.

Crime scene photos are supposed to provide views of the area as would be seen by an average observer. A set of four photos is the minimum to show a room. Medium and close-up shots should be taken of important items. You will find that a wide angle lens is nearly a must for crime scene photography.

c. Burglary and vandalism. In this type of photography you are again interested in the scene. You should get photos of:

- General view.
- Point of entry/exit.
- Condition of scene.
- Articles left at the scene.
- Marks from tools, shoes, and tires.
- Areas from which items were removed.

d. Homicide. Your photos here should set the scene, provide information concerning the manner of death, and show if the crime was connected with a burglary.

To help investigators later determine the manner of death and locate the body in relation to the other articles in the scene, produce at least two photos of the body. These should be taken at right angles to each other. Point the camera down from a normal standing position. Other photos should include close-ups of the wounds, location of the instrument of death, and other special aspects of the body.

e. Hanging. Photograph the original position of the body to help in determining the manner of death. Take an overall view of the body and rope. Show the height of the body above the ground. Show the relative position of objects, such as chairs or stools, which appear to have been kicked out from under the victim's feet.

f. Drowning. In drownings, the body is usually the sole object of interest. Color film is usually helpful since many of the clues may be matters of discoloration. Photograph the entire body from a standing position and from ground level. Close-ups should include foam about the mouth, wounds, peculiar markings, bruises, or unusual discoloration.

g. Assistance. If you have a problem at the scene be sure to ask the person in charge for help. This person may be from the safety office, fire prevention, security police, medical, or the Office of Special Investigations (OSI). Be sure you know what you are doing and that you do not interfere with the other people who are trying to do their jobs.

Exercise **(418)**:

1. From the following examples, determine if the photographer acted properly:
   a. When called on to photograph a suspect, Airman Jones positioned his lighting so that it hid a scar on the suspect's face.

   b. While at the crime scene, Sergeant Smith needed a shot of a knife which was partially hidden. He took as many pictures as he could from different angles, but he did not move the knife nor anything else.

   c. At a scene of a hanging, Airman White took several shots of the entire room. Then she made some photos of the body. These photos included the body and a chair which was turned over.

2-10. Operator Maintenance

So far we have told you how to handle certain shooting situations. We have made the assumption that all of your equipment was in proper working order. In this section, we will cover operator maintenance. We cover some of the things you can and should do to be sure your equipment will work when you get to your mission area.

419. Cite principles and requirements of camera operator maintenance.

General Principles. Give all items of photographic equipment an operational check prior to using them. Some items that fall into this cateogry are camera bodies, shutters, film holders, tripods, flash equipment, rangefinders, timers, processing equipment, lenses, and diaphragms. In the course of a single year your cameras and accessories may be exposed to the extremes of the elements such as snow, rain, heat, cold, and humidity. Exposure to the elements can be a problem. Unless protected, mechanical parts get rusty, bellows mildew, leather dries out, lens elements separate, and gear trains wear out, to name a few problems.

Modern cameras are masterpieces of electrical, mechanical, and optical engineering. With proper care and periodic maintenance they will give years of trouble-free service. Many times the condition of the equipment and tools that people use in performing their daily tasks can tell a lot about the quality of work that they perform. A person who keeps his equipment clean and neat gives the indication that he cares about his work. For example, if you needed to have your car repaired, you would probably be more trusting of the mechanic who keeps his tools in top condition and neatly arranged on his workbench. Most of us would be suspicious of the person who has set up shop under a shade tree and stores his tools on the ground. A mechanic's tools can be compared with the equipment that you use in photography; cameras, tripods, flash units, etc. Each of these items are the tools that you must depend on every day to get the work done. The mechanic who doesn't maintain his tools properly is liable to break a knuckle or twist off a bolt. Likewise, if your camera fails to work when you need it, you have blown the assignment.

Maintaining Your Camera. Cameras are the most basic tools of photography. A camera is a relatively delicate instrument and must not be subjected to rough handling and abuse. Dropping a camera usually results in extensive damage, often rendering the camera unusable. Always carry your camera in such a way that they cannot be accidentally dropped. Most 35-mm and medium-format cameras are equipped with a neckstrap. Check the condition of such straps often to insure that they will still support the weight of the camera.

Whenever a camera is not in actual use, the lens should be covered with a lenscap and the camera protected in a ready case or carrying case.

Protection from heat. Never submit any camera to excessive heat. An example would be leaving a camera inside a locked automobile on a sunny day. Dark camera cases of brown or black leather, although, very stylish and therefore popular, present problems if left sitting in sunlight. When on an assignment, make sure that you do not leave your camera case exposed to direct sunlight for prolonged periods of time.

Excessive heat does nasty things to photographic equipment and film. High heat will fog your film. A lens left uncovered in direct sunlight can focus the sun's rays on the focal plane shutter of a camera and in some cameras actually burn a hole in the shutter. Excessive heat can also cause lens elements to separate.

Humidity. A humid environment takes a heavy toll on photographic equipment. It can cause fungus to grow between lens elements. It promotes the formation of mildew which attacks leather and vinyl surfaces such as camera bellows, camera bodies, and cases. Of course, metal parts corrode much more readily in a humid environment. Keeping ahead of the effects of humidity involves continual checks on equipment and adequate protection both while in use and in storage.

When cameras are to be stored for long periods of time, a dehydrating agent such as bags of silica gel should be packed with the camera. Never seal cameras and lenses in plastic bags because this will only promote corrosion. Plastic bags are nonporus and they retain moisture.

Occasionally you may have the misfortune of getting caught in a rainshower while out on an assignment, or you may have to cover an accident in a downpour. Try not to get your camera wet. It is a good idea to carry a large plastic bag with you. Place the bag over your camera and shoot through a hole made in the bag. There are commercially available plastic covers which serve the same purpose and are a wise investment in areas that have a lot of rainfall. Immediately upon returning from the assignment you should carefully remove all moisture from the camera exterior and then remove the lens and open the camera back to check the camera interior for moisture. Unless you were really careless and got your camora soaked, you probably won't find any moisture within the camera. Moisture within the camera requires immediate disassembly by a camera repairman. Don't attempt to tear down a camera yourself. This is work for a qualified repairman.

Cleaning and adjustments. Before going out on a camera assignment always perform an operational check on your photographic gear. The camera should be clean and all controls working properly. Cleaning procedures are best performed after returning from an assignment because the equipment has been subjected to the elements.

The first step in cleaning a camera is to remove all dust and dirt from the camera body exterior and the exterior of the lens barrel. Use a soft brush and then polish metal surfaces with a soft, lint-free cloth to remove smudges.

Camera lenses require special care. The surfaces of modern lenses are given an antiflare coating during manufacture. This coating is fairly tough, but it can be damaged if the lens is not cleaned properly. Gently blow off any dirt and dust on the lens surface using your breath or better yet, use an air syringe. The lens can then be polished using photo lens tissue. *Always* use only photo lens tissue. *Never* use lens tissue designed for cleaning eyeglasses. Eyeglass cleaning tissue usually contains silicones which can damage the coating of photographic lenses. To polish the lens, grasp a sheet of lens tissue between your thumb and forefinger and polish using a circular motion working from the center of the lens to its edges. Sometimes when a lens has been neglected, polishing with photo lens tissue will not get it clean. Should you have this problem you can use photo lens cleaning fluid. *Never* apply the fluid directly to the len because it can seep past the front lens element and cause interior lens damage. Apply a few drops to a piece of photo lens tissue and then apply it to the lens. The lens can then be polished using a dry piece of lens tissue. Cleaning is the most important part of operator preventive maintenance.

Other than keeping your cameras clean and protecting them from damage there is little else that you can or need to do. All photographic equipment should be scheduled for periodic maintenance by qualified equipment maintenance personnel. Any minor problems that you have been experiencing with your equipment should be noted, and this information should be given to maintenance personnel at the time your equipment is turned in for periodic maintenance. Periodic maintenance is conducted at 60-, 90-, 120-, or 180-day intervals, depending upon the particular type of photographic equipment involved.

Check the operation of your cameras and equipment often, especially before and after it is used. The shutter on any camera should never be left cocked for long periods of time. When not in use the shutter should be set at its slowest speed. These actions take the tension off of shutter springs and mechanisms, thereby extending their life and maintaining their accuracy.

Rangefinder cameras. Rangefinder-focusing cameras should be checked periodically to insure that they are focusing properly. This is something that you can check for if you are using a camera that has both rangefinder and ground-glass focusing such as the Graflex XL. Place the camera on a tripod and focus the camera on infinity with the rangefinder and then check the focus on the groundglass. Repeat this procedure on a close object. If the rangefinder is out, it requires immediate attention by a repairman. Don't attempt to make any adjustments yourself.

Cameras with bellows. The flexible bellows used on view and copy cameras should be checked periodically for light leaks. This is especially true if you are experiencing film fogging. Take the camera into a light-tight darkroom, remove the lens and back from the camera, and probe the inside of the bellows with a flashlight.

Mechanical flare. Mechanical flare is often caused by internal reflections from bright surfaces within the camera and also near the lens. Check the lens shades, retaining rings, and the camera interior for places where the black paint has been chipped, exposing bare metal. These spots can be touched up with a flat black paint. Check with a repairman on the type of paint that should be used.

Reflex mirrors. The mirror of reflex cameras should not be touched. Blowing dust from its surface with an air syringe should be all that is required.

Flash Lighting Equipment. Maintaining electronic flash units is relatively simple. Electronic flash units have a series of capacitors which store electrical energy at very high voltage. Tripping the strobe causes this energy to be applied to a flash tube filled with an inert gas. As the current flows through the tube it causes a very bright but extremely short burst of light. In order for the unit to operate at maximum efficiency and put out the maximum amount of light, a technique called *forming* or the rejuvenating the capacitors must be done.

Forming the capacitors allows them to take a full electrical charge. This is done initially when the unit is first put into use and must be reaccomplished each time the unit has not been used for a few days. Most professional electronic flash units operate on both household current and batteries. Regular AC can be used where there is an available outlet, and batteries can be saved for those occasions when it is not available or not practical. Household current should be used when forming the capacitors of the unit. To form the capacitors the unit is connected to the power source and allowed to take a charge. The unit is then fired a number of times at a set interval. This procedure may be different for each type of flash unit, so check your instruction manual.

The types of batteries used in electronic flash units are either the dry cell or rechargeable (nickel-cadmium) type. Dry cell batteries are probably the most convenient because they are discarded when no longer usable and quickly replaced with fresh batteries. However, dry-cell batteries are expensive and the rechargeable nickel-cadmium are becoming more popular. Nicads offer the same advantages of portability as dry cells, and because they can be recharged, they are much cheaper in the long run. They must be maintained properly if they are to give good service. Nicads actually benefit from continuous service, and they should be fully discharged before being placed in a recharger. This improves their ability to take a full charge. Nicads left in storage for extended periods of time will drain. Nicads lose their ability to take a full charge if they are not fully discharged periodically. Use your electronic flash unit daily, recharging only when necessary, and you should have no problems.

Exercises (419):

1. How should you carry a camera?

2. Why must you protect your camera from heat?

3. List two problems that high humidity can cause.

4. If you got your camera wet, what should you do?

5. Why shouldn't you use eyeglass tissue to clean a camera lens?

6. How can you repair a camera that shows mechanical flare?

7. What is the purpose of forming the capacitor?

8. What protective devices should be used to protect a camera when it is not in use?

9. At what time(s) should you perform an operational check of your camera?

10. Why must you never apply lens cleaning fluid directly to a lens?

11. At what speed should you set the shutter if you are storing a camera?

Studio Assignments

MOST OF THE assignments we covered in Chapter 2 were of an uncontrolled nature. When you move into the studio, things become far less hectic. You can have the camera and lights set up before the subject arrives. After the subject arrives, you can move the lights, the camera, and even the subject. All of this can be done under very controlled conditions, and you can tell what the final effect will be before you trip the shutter.

Your studio work, like your other work, will improve with practice, experience, and counsel from others. In this chapter, we will try to start your experiences off right with the techniques, principles, and some more helpful hints for you to use in the studio. We will cover portraits, passport and identification photos, special assignment photos, and operator maintenance.

3-1. Portrait Photography

A portrait is not just another photograph. It is a carefully composed portrayal of a person often used for publicity purposes or as a method of identification. (Identification and passport photography will be covered in a later section.) Good portraits do not just happen—they result from careful application of many different techniques. Above all, good portraits usually result from many years of experimentation and practice. Making good portraits requires both artistic and photographic ability. Portraiture often involves working with persons of senior rank, children, and members of the opposite sex. Self-confidence and the ability to handle people properly are extremely important.

420. State the requirements for portrait photography.

Portraits are an important part of any base photo lab mission. Portraits are used in personality features, for keyman and chain-of-command displays, and for the very important AFR 36-93, *Official Photographs*, requirements. Let us discuss each one of these.

Personality Features. People are interested in other people. On every base there are thousands of individuals who are contributing to the Air Force mission. Their individual accomplishments can be spotlighted by a picture story. Such a story would be highlighted by semiformal and informal portraits of the individual. Most of these pictures would be taken at the individual's place of work or when he is taking part in the activity that has made him stand out.

Groups, too, can be considered. Portraits of the winning softball team or a group of volunteers who make monthly visits to a home for the aged are common examples. These portraits are taken on location and emphasize the group's particular accomplishment.

Keyman Pictures. Each level of command has key personnel who hold leadership functions. To spotlight their responsibilities, their portraits appear on bulletin board displays. Such portraits are usually head and shoulder poses taken in the studio. They should be dignified military portraits.

Chain-of-command pictures follow this same principle. In each headquarters building there is usually a display of photographs showing a chain of command stretching from the President to the base commander, etc. Many of these photographs are supplied by higher authority. The pictures of the local commanders are similar to the AFR 36-93 format that will be discussed next.

AFR 36-93. AFR 36-93 requires officers to maintain official photographs in their personnel records. These photographs are important as they become part of the officer's promotion folder. The updating of these pictures is spelled out in the regulation. As photographers we are most concerned with the following specific picture requirements.

Position camera height approximately level with the officer's eyes. Use a light colored backdrop (white, gray, or light blue), which will assure a neutral background. The pose will be formal, showing head and shoulders with the face directly toward the camera and the body turned approximately 30° to 45° to the right so the left shoulder is forward to the camera and the name tag is visible.

Finish the portraits on 8 by 10 inches, black-and-white, single-weight glossy paper with 1/4-inch border on top and sides, 3/4-inch border on the bottom.

Reproduce an identification frisket in the lower left corner of each print, 1 inch from the lower edge, measuring approximately 1/2 by 3 inches on the prints and not covering the name tag or any ribbons or badges. The frisket will display the officer's last name, first name, middle initial, rank, Social Security Account Number (SSAN), and date the photograph was taken. The identification data must be easily read and present a positive, unquestionable contrast between black-and-white in order that a subsequent microfilming process may be accomplished satisfactorily. Gummed or pressure sensitive labels will not be used to record identification data on photographs.

It is very important that a current form of the regulation be available at all times, since the officer will be relying on your knowledge and judgment to carry it out. It will require quite a bit of tact on your part to point out to an officer when his appearance or dress does not conform to the necessary standards. (Fig. 3-1 shows an example of an AFR 36-93 photograph.)

Exercises (420):

1. What is the key ingredient of the personality portrait?

2. List three basic categories of portraits you may be taking.

3. Why is it important to keep up with AFR 36-93?

4. Why must you often exercise tact when taking AFR 36-93 portraits?

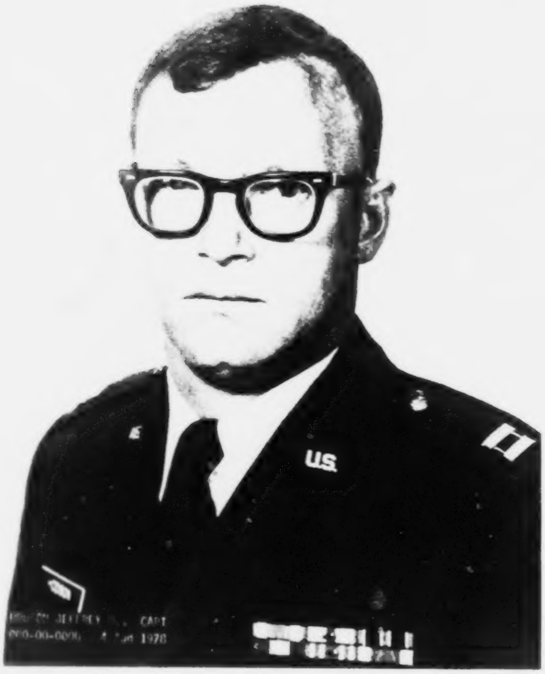

Figure 3-1. Official officer's portrait.

421. Point out principles and techniques of good portraiture in terms of equipment, the subject, composition, perspective, and lighting.

Most of your portraits will be taken in the controlled environment of your lab's portrait studio. The principles of good portraiture are also applicable to location shooting. To help you along we will discuss equipment, working with the subject, composition, perspective, and lighting. It must be emphasized, because of the number of variables and infinite possibilities, that only through practice and intelligent analysis of your results can you master this very rewarding photographic skill.

NOTE: It would be to your advantage to read about and examine the work of such great portrait artists as Arnold Newman, Yusof Karsh, and Phillippe Halsman.

Equipment. Prior to the portrait sitting it is important to analyze the work order so that you have a clear idea of the requirements. A "36-93" may call for a different approach from that of photographing the president of the Officers' Wives' Club. The finished product that is required will also be an important factor in determining the type of film and the camera you will be using. Thoughtful preparation will save you time and insure good results.

Generally, you will be using a 4 x 5 camera for portraiture. Such large negatives permit retouching and produce high-quality enlargements. You will want to use a fine grain film and developer combination to insure top quality.

It is essential to have your equipment ready for use before the portrait sitting begins. Check lamps, flash units, shutter, film holders, support equipment, and general camera operation. Have one of your associates assume the position you plan to use. While your assistant is in the correct position, establish the general lighting effect desired, the camera position, and the approximate bellows extension for proper focus. Go through the normal setting up operations that are required. After all of the preparatory steps have been completed, turn off the lights and await the arrival of your subject(s).

Putting the Subject at Ease. Many people freeze in front of the camera. If you know what you are doing and if you can give the subject the impression that you understand your business, it will go far to dispel his nervousness. When posing the subject, verbally direct him into the desired position. A good portrait photographer seldom finds it necessary to touch the subject. However, if you must adjust clothing or do something for the subject that he is unable to do for himself, be polite, explain why the action is necessary, and ask permission to take the action. Remember that most people become very annoyed when they are "pushed about," but they usually cooperate readily if you are polite, gentle, and give adequate reasons for the action that is being taken.

NOTE: Portrait subjects are normally quite concerned with their appearance. It is a good idea to construct dressing rooms with mirrors to provide a place for people to "check themselves out" before the sitting.

Portrait Composition. The simplest form of portraiture is undoubtedly confined to head and shoulder shots. Apart from placing the head, there are few compositional problems. When more of the subject is included, as in a three-quarter shot, the placing of the hands and the pose of the figure becomes of great importance.

Since personal comfort leads to more graceful positions being assumed, it is usually desirable to give the subject some support. For example, in the case of a head-and-shoulders portrait, a stool may be used. A full-length portrait, of course, permits no support.

The background is very important. Most portraits are posed against a very plain background. Many of these backgrounds are in effect portable screens designed for portrait studios. If you keep the background well away from the subject, you will throw it out of focus and create an appearance of space.

Your choice of focus and depth of field will be an important factor in how pleasing your composition will turn out. Normally, you focus on the eyes and use a fairly wide open f/stop to insure rapidly decreasing sharpness. The purpose of the portrait is for the face to stand out from the environment. Occasionally, when doing location shots or where a particular prop related to the subject is an important element in the picture, greater depth of field may be necessary to get your picture message across.

NOTE: When shooting color consider the color of the subject, background, and any props. It is important that there be a harmonious blending of these various colors.

Perspective. The perspective of a portrait will be determined by the position of the camera in relationship to the subject. Whether the camera is near or far, high or low, or at eye level will make a difference in how the subject will appear. Normally, for a head-and-shoulder portrait, the camera is level, with the optical axis of the lens between the height of the subject's lips and tip of his nose. For a three-quarter figure shot, the center of the lens is level with the upper chest. For a full-length figure, lower the camera again until it is level with, or a little below the waist. You should also maintain a good working distance so you do not have any distortion.

NOTE: There are recommended focal lengths for different size films and types of portraits in order to maintain a good image size. For example, consider these for a 4 x 5 camera: 8½ to 10 inches (200 to 250 mm) for a head and shoulders and a 6-inch (150 mm) for a full length.

Lighting. Lighting along with subject placement is the key element in successful portraiture. Lighting can come from either natural or artificial sources or combinations of the two. Its direction and intensity will determine how the contour of your subject's face will appear.

The single most important principle you should apply to achieve correct lighting is that there should be only ONE DOMINANT LIGHT SOURCE with all other lights subordinate to it. To do otherwise will cause confusing shadows and light directions. To better understand this, let us consider the use of four lights: main, fill-in, hair, and background. Using these four lights in the studio will allow you to perform almost all of your portrait assignments.

The main light. Generally, this is a flood lamp or broad light source located higher than the subject's head and at approximately 45° to one side of the camera-subject axis. The light is often diffused with a screen to reduce facial textures and eliminate harsh shadows. The positioning of the main light is the key to your lighting and therefore must be considered with great care. Normally, you will use it to establish either broad or short lighting. (See fig. 3-2.)

In broad lighting the main light fully illuminates the side of the face turned TOWARD the camera. This type of lighting is mainly used to help "widen" thin faces.

Using the far more common short lighting, the main light illuminates fully the side of the face turned away from the camera. This lighting is used for the average oval face and it tends to emphasize facial contours

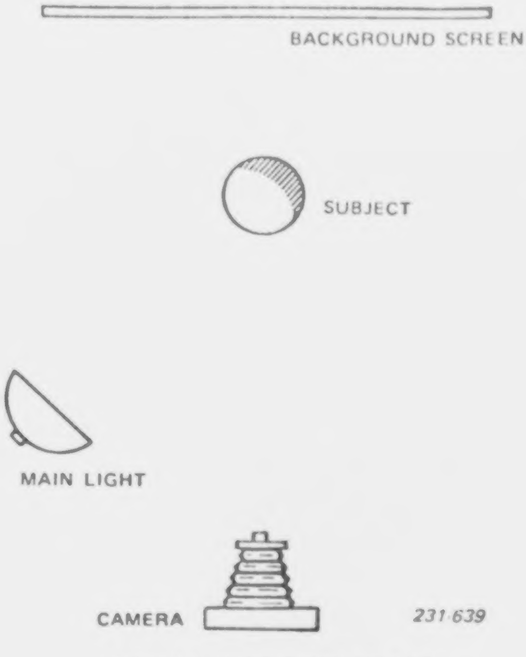

Figure 3-2. Positioning the main light.

more than broad lighting. Its effect can also be used to narrow plump or round faces.

One method of placing the main light, regardless of the type of lighting, is to watch the resulting catchlight (reflection of the light) in the eyes. As seen from the camera-lens position, these catchlights should be located at approximately the 1 o'clock or 11 o'clock position in the eyes depending on the result desired.

NOTE: To position electronic flash units you will have to rely on a modeling light. The use of a modeling light takes experience since it is often much weaker than the resulting flash. This is why it is better for the beginner to learn portraiture using photoflood lamps.

The fill-in light. The fill light is diffused, used close to the camera at lens height, and placed on the side of the lens opposite that of the main light. Its purpose is to soften the shadows cast by the main light. (See fig. 3-3.)

Almost inevitably the fill light will add a lower pair of catchlights to the eyes. These secondary catchlights should be etched from the negative or spotted from the print to create a more pleasing effect.

The background light. The background light is a small lamp on a short stand placed about midway between the subject and the background. This light provides good tonal separation between the subject and the background. (See fig. 3-4).

The hair light. This is usually a small lighting unit attached to a boom so that it can be established above and behind the subject. Normally, the light is positioned directly overhead, either to the right or the left of the subject's hair at head level, or above and to one side. The key is don't let the light spill over onto the face, thereby creating unwanted highlights. (See fig. 3-5.)

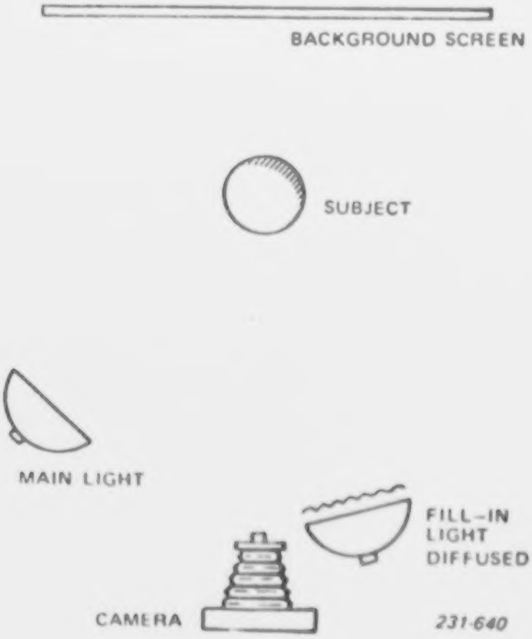

Figure 3-3. Add the fill-in light.

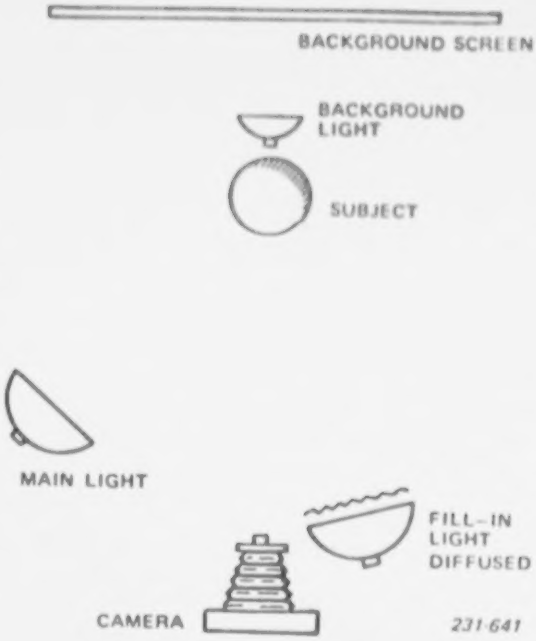

Figure 3-4. Add the background light.

NOTE: To establish the lighting the way you want it, it is best to position each light separately with the other lights off. Some photographers start with the background light, then move to the main, fill-in, and hair lights. (To better understand the difference between broad and short lighting using four lights, compare fig. 3-6 with fig. 3-7.)

Lighting Controls. Good portrait techniques require you to bring out the best features of the subject and tone down the worst. By proper use of equipment and lighting techniques, you can achieve the desired outcome to a certain degree. A wrinkled face under normal lighting conditions would produce harsh shadows and emphasize the wrinkles. To tone down the wrinkles, use a diffuser over the light source. A diffuser softens the light and reduces contrast.

Often you will want to control where the light strikes your subject. Baldness is a trait most people do not want emphasized. To control the problem, a head screen or barn doors can be used to shade the light striking the head.

Lighting ratio. Lighting ratio refers to the relative intensities at the subject position of the main light plus the fill-in light, as compared to the fill-in alone. This ratio creates the contrast of the portrait. Normally, a ratio of 3 to 1 will result in pleasing contrast. Higher ratios are more dramatic but are likely to be unacceptable for official record portraits. Here are a couple of ways to establish a 3 to 1 ratio:

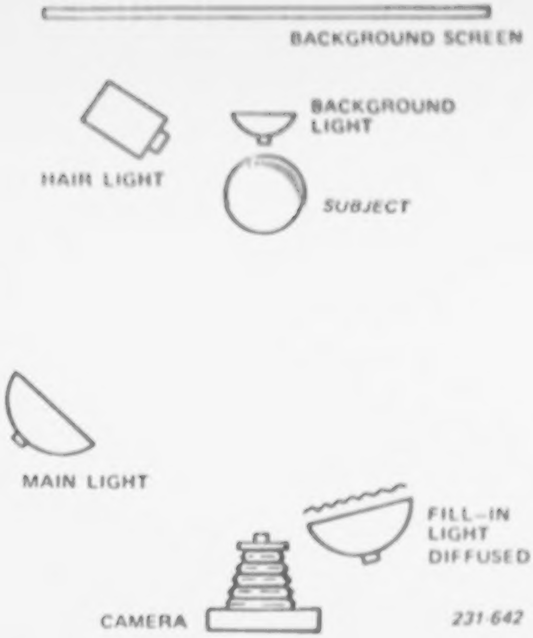

Figure 3-5. Add the hair light.

- Establish both the main and fill-in light at equal distance from the subject, but cut the strength of the fill-in by one half. This can be done through power settings or by using a diffusing screen over the fill light.
- With two lights having the same strength, move the main light one f stop closer to the subject. For example, if the fill light is 11 feet away from the subject, the main light should be 8 feet away.
- Take an exposure meter reading (reading may be incident, reflected reading off a gray card or the use of a flash-meter) at the subject of the main plus fill-in, and then the fill-in alone. In this way you can calculate your ratio.

Portrait lighting is exciting and requires quite a bit of practice to be expert. Take the time to practice this skill so you will be ready for your first portrait mission.

Exercises (421):

1. Complete the following statements on portraiture:
   a. By using a large format camera you will have portrait negatives that can be ____________ and readily ____________.
   b. The subject will not ____________ in front of the camera if you establish rapport.
   c. When taking a portrait, you normally focus on the subject's ____________.
   d. Normally when taking a portrait, you will want ____________ depth of field.
   e. For a three-quarter shot, the center of the lens is level with the subject's ____________.
   f. When using a 4 x 5 camera, you would use a ____________ inch lens for a full-length portrait.
   g. There should be only ____________ dominant light source when taking a portrait.
   h. To position electronic flash units, you must rely on the ____________ lights.
   i. In broad lighting, the main light fully illuminates the side of the face turned ____________ the camera.
   j. In short lighting, the main light fully illuminates the side of the face turned ____________ from the camera.
   k. A lighting ratio of ____________ will give you pleasing results.
   l. The main light plus the fill light, as compared to the fill, establishes the ____________.
   m. To de-emphasize the wrinkles in a subject's face, ____________ the main and fill-in light.
   n. The use of ____________ or a ____________ ____________ can control where the light falls on the subject.
   o. To establish a 3 to 1 lighting when the main light is 5.6 feet from the subject, a fill of equal strength should be place ____________ ____________ away.

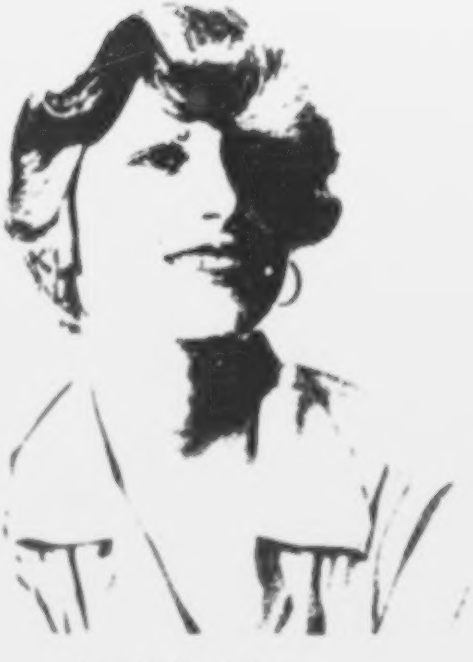

Figure 3-6. Broad lighting.

3-2. Identification and Passport Photography

Nearly all Government agencies and military installations use photographs on passes, identification cards, badges, and passports; and in personnel files and records as one of the means of positive identification of personnel. For each particular assignment, the requirements of size, pose, etc., may differ. Therefore, *before you make any exposures, consult the appropriate regulations to determine the exact requirements that the photographs must meet.*

422. Specify the requirements and some of the photographic techniques used in identification and passport photography.

You must never forget that the purpose of the *identification photograph is just that*—a photograph from which the person can be identified. Its purpose is not

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to "glamorize" the subject or make the individual look "pretty"; it is to portray any and all features, both good and bad, which serve to identify that particular individual from all others.

Photography is one of the most positive and economical methods of identification. For this reason pictures have long been used for identification purposes. In recent years, there have been two noticeable trends in identification photography: (1) the emergence of new and varied applications and (2) a sharp increase in the use of color photos. Let us therefore take up the requirements of passport and identification photography.

Passport Photography. The Department of State is the authority for passports. It establishes the guidelines for submissions of applications for passports. The portions you need to be most interested in deal with the photos that must be included with the application.

Size. The image size of the subject's head must be no less than 1 inch and no larger than 1⅜ inches. This measurement is made from the bottom of the chin to the top of the head including hair. An easy way to keep the image of the head the proper size is to mark the ground glass at the proper places and then when you compose, keep the image of the head between your marks.

Sometimes you may need to have two or more people in the picture. If this is the case, the image must be large enough so that each person can be easily recognized.

When the passport picture is printed, it must be 2 x 2 inches. Usually it is contact printed. Therefore, it is a must that the picture area on the negative be 2 x 2 also. You may wish to mark the ground glass for this measurement, too. A piece of paper or film leader with a 2-inch square hole in it may be used on the ground glass instead of marking it with a grease pencil.

Posing. The subject may be shown as relaxed and smiling. The photo must portray a good likeness of and satisfactorily identify the subject. The subject should be in normal street attire, without a hat. Dark glasses are not acceptable unless they are required for medical reasons. Applicants who are in the active service of the Armed Forces and who are going abroad in the discharge of their duties may be shown in the uniform of the Armed Forces of the United States.

The subject must be shown in a clear, front, full face view against a plain light background.

Paper. Two prints of each applicant must be made on thin, nonglossy paper. They may be color or black-and-white.

Identification Pictures. Identification pictures are made for use on all types of military ID cards and classified area badges. Identification photography is often done by the Security Police since identification forms are normally filled out and registered in the Security Police, Pass and ID section. The size of the identification picture cannot exceed 1 x 1¼ (2.54 x 3.18 cm) inches in a vertical format. It must be a full front shot of the face and cannot be retouched. The picture will also include a title board containing information set down by pertinent directives.

This type of identification photography is often done with a Polaroid camera designed for identification work. Such a camera permits quick results with a number of different lighting setups. More importantly, a nonprofessional photographer can be trained to operate it and make the necessary adjustments to obtain satisfactory results.

Lighting. The lighting arrangement used for any identification or passport-type picture must be even, well-balanced, "flat" lighting. This type of lighting will not hide any identifying facial marks, such as scars, moles, etc., which could be used for definite identification of the individual. To obtain flat lighting, both the main and fill light are placed at a 45° angle to the subject, giving you a 1:1 lighting ratio.

Exercises (422):

1. What is the purpose of an identification photograph?

2. Which Government agency provides the guidance for producing passport photos?

3. What is the smallest size a passport photo may be?

4. What type of lighting should you use for passport and identification photos?

5. Explain why you should not try to glamorize passport and identification photos.

3-3. Special Assignment Photographs

Suppose you wanted to be an instructor at Lowry in the Basic Still Photo Course. What would you do? You would go to your CBPO to find out how to apply for instructor duty. Among all the other requirements, you will find that you have to send two full length photos of yourself in uniform along with your application. Since you are a photographer, this is no problem. But what about all the other people on base who would like to be instructors in their career fields, or the people who are applying for some other type of special duty assignment? If they need a photo to send with their application, where do they go? Simple they come to your lab and you will have to produce the pictures of them for their application.

423. Specify requirements and techniques for special assignment photographs.

There are so many different types of special duty assignments we cannot cover all of them. AFR 39-11, *Airman Assignments*, gives guidance on how to apply, where, and what procedures to follow. The part of the regulation you are interested in is the appendixes that tell you how many and what kind of photos need to accompany the special duty application. The people at CBPO who make out the photo work request should specify this information. However, it couldn't hurt to have this information handy in your lab.

All special duty photographs must show the applicant in full length. Some require only a front view, while others require a profile. In some, you may have to include the applicant's dependents. This information should be on the work request.

Lighting. As in other identification-type photos, special duty photos should have flat lighting. You may find some lighting problems in special duty photos that you did not have in other portrait work.

Main and fill. In head and shoulders portraits you have to light a smaller area than you will in full length photos. When you set up your lights, don't forget to illuminate the subject's feet. In applications for instructor duty, you need to include a letter board to show the subject's height and weight. Place the board on the floor near the subject's feet, and then check to see if you have lighted it well enough to be legible.

Background light. When you shot the head and shoulders-type photos, you could hide the background light behind the subject. In a full length shot you may not be able to do this. Check through the groundglass to see if you can see the background light. If you can't, that's good. If you can, you will have to move the light. You may have to use two lights, one on each side of the subject.

As with the main and fill lights, be sure you check the illumination from head to toe. The object is to have even lighting on the background, from the floor to the top of the subject.

Group lighting. Certain types of special duty photos must include the applicant's dependents. Lighting a group of three or four people involves some more problems that you did not have with a single subject.

You will probably have children in the group. They should be standing in front of the parents. In this arrangement, you have essentially two groups; one group of two or three children in front and one group of two parents in back.

Place the lights so that the children and the parents receive the same amount of illumination. You may have to modify the standard two-light setup. Watch for shadows of each person falling on another person.

The background light may be hidden behind the group. If not, you will have to use two background lights as you did with a single person.

Composition. Composing a special duty photo should present no problems for you. Have the single subject stand up straight. Place him in the center of the picture. Leave room at the top and bottom of the picture to be sure you don't cut part of the applicant out of the picture.

Arrange the people in a group so that you can see all of them. One of the parents may have to hold a small child. Watch your composition to be sure the child being held does not interfere with any of the other subjects.

When you compose, look for distractions. Be sure that you cannot see any of the lights or electrical cords in your picture. Also, check for glare in the subject's eyeglasses. This can be corrected by raising or lowering the lights or by having the subject tilt his chin up or down.

Another type of distraction is the applicant's uniform. As in AFR 36-93 photos, you may have to be very tactful when you tell a person that his ribbons or collar insignia are on wrong.

Focus. Obviously, if you want a photo of a person, you will want to be able to see that person. Therefore, focus is important. You should focus on a single subject's eyes. In a group, recall the depth of field and 2/5ths rules we discussed in Volume 2.

As you compose, you may be inclined to tilt the camera in order to include all of the subject(s). Doing this causes the camera back to be tilted from the vertical plane the subject occupies. If this happens, recall our previous discussion about view camera controls. Keep the film plane parallel with the subject.

Exercises (423):

1. Which Air Force regulation should you look in to find out how many poses are necessary for an instructor application?

2. What type of lighting should you use for special assignment photos?

3. In full length photos, which area of the subject is sometimes forgotten when the lights are set up?

4. What might you have to do with the background light when you are taking a full length photo?

5. How much area of the background should be lighted?

6. When you are lighting a group of children and parents, how much light should fall on the children?

7. What are two distractions you should look for when composing a special duty (or any) portrait?

8. On what part of a single subject should you focus?

3-4. Reflectors and Umbrellas

We mentioned earlier that photography means making pictures with light. In this section we will cover two more devices that help you control your light so that you can become a better photographer. These two devices, reflectors and umbrellas, are easy to use and will enhance the appearance of your final product. Since they are generally used in the studio, we include them in this chapter.

424. Specify various principles and techniques associated with the use of reflectors and umbrellas.

Reflectors. In Volume 2, we discussed various qualities of light. We said that light which bounces off an object is reflected light. In this section, we will show you how to use reflected light and how to control it by using an effective lighting device we call a reflector.

The efficiency of any light source is increased if you use a reflector. The reflector helps by directing the light into a specific area. That bowl-shaped device that surrounds the studio light is a reflector. But have you thought of using a supplementary reflector—one that is not connected to the light?

Supplementary reflectors can be anything you can use to reflect the light into an area where you want it. Reflectors can be cardboard, paper, a handkerchief—almost anything. A very useful reflector can be made by wrapping aluminum foil around a piece of cardboard. Reflectors can be used quite easily; they are light weight, and they never need electrical power.

If you need just a little more light in an area and you can't or don't want to use another light, you may wish to use a reflector. You will need to develop a very critical eye so that you can see the effects of your lights.

Reflectors are most often used to direct light into the shadow areas. The intent is not to illuminate the area, but rather to complement the highlight area. You do this so that you get a pleasing lighting ratio.

Suppose you are lighting a piece of equipment for an MDR photo. You main light is producing the desired effect but you still have too much shadow area. You could use a fill in light. But suppose this creates another undesirable shadow or too much light. You could use a reflector to bounce additional light into the shadow area. You might bounce the main light from a reflector onto the subject.

The whole point is that you must not allow yourself to become accustomed to doing things the same old way all of the time. Experiment with your lighting setup.

You might want to think of using reflectors in the interests of energy conservation. If the illumination is available, use it. If a reflector will get the light where you want it, don't use another light; use a reflector.

Exposure. A bare light without a reflector obviously will not direct as much light to the subject as a light with a reflector. Therefore you have some exposure calculations to consider. If you are going to make the exposure without using a reflector, then make your exposure calculations that way.

If you are using a main light and a supplementary reflector be careful in making your exposure calculations. You need to determine if the light from the reflector is affecting the overall illumination or is just filling in the shadows. If the former is true, then you need to compute your exposure by including this light in your calculations. If only the shadows are being affected by the reflected light then you can base your exposure on the main light alone.

Umbrellas. An umbrella, as shown in figure 3-8, is just one more type of lighting equipment. Umbrellas

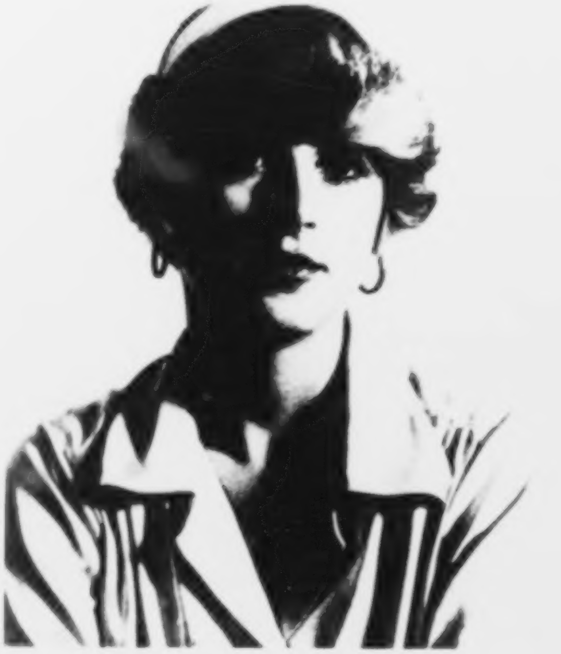


Figure 3-7. Short lighting.

are generally used in the studio, but they are light enough to be carried around and used almost anywhere.

Umbrellas are really no more than just another form of reflector. In addition to being very light, umbrellas can be collapsed for easy transport. Umbrellas are available in a variety of shapes and sizes. Some are less than 18 inches (45.7 cm) in diameter, while others are 80 inches (203 cm) across. Some common shapes are parabolic, spherical, and conical. Their reflective qualities depend on the material used to make them. Some are no more than white cloth, while others are made with highly reflective material.

Umbrella lighting is a very adaptable type of indirect, diffuse light. Since it is diffused, we generally associate umbrella lighting with soft, shadow-free lighting. As soft as umbrella lighting is, you can diffuse it even more. You can bounce the light out of the umbrella onto another reflector, wall, or ceiling.

Exposure. If you are lucky enough to have an automatic electronic flash, exposure will be no problem at all. If you don't have an automatic strobe, maybe you are fortunate enough to have a flash meter. If you don't have either one, you will need some time, patience, and ability to take notes.

You know that the farther light has to travel the less there will be. Since you are bouncing the light onto the subject from an umbrella, obviously you will lose some light. Since you lose some light by using an umbrella, you will have to determine how much.

Without a flash meter, you will have to make some tests. Your testing procedures are not very difficult if you remember the section in Volume 2 about guide numbers. You need to apply those principles to establish a guide number for use with an umbrella.

Remember that the proper exposure for flash is determined by dividing the distance of the flash into the guide number. To establish a guide number, you must determine the proper f/stop; then multiply the f/stop times the distance.

For example, set up your flash with the umbrella at 10 feet from a subject. Shoot one exposure at each f/stop. Develop the negatives and find the one with the proper exposure. Suppose this was f/8. Multiply 8 (f/stop) times 10 (distance) and you have established a guide number of 80. This guide number can then be used with that umbrella and flash unit for any other assignment.

Umbrella lighting is ideal for portraits if you want to diffuse the light. Figures 3-9 and 3-10 show the effects of straight, harsh lighting and diffused umbrella lighting.

Don't get the impression that umbrella lighting is used only for portraits. You can use it very effectively for photos of static objects. Figures 3-11 and 3-12 show how umbrella lighting can be used to soften shadows and give more even, diffused lighting.

We remind you again that photography is an art form. An artist needs to learn how to apply paint to produce a picture. You need to learn how to apply

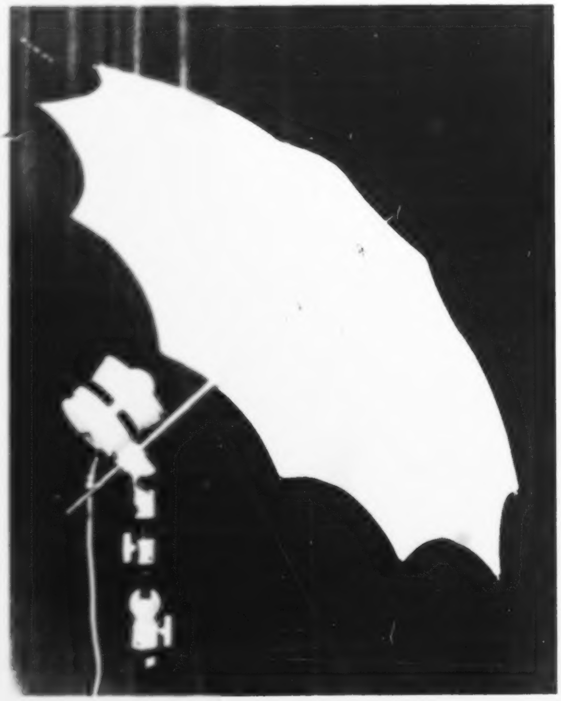


Figure 3-8. An umbrella.

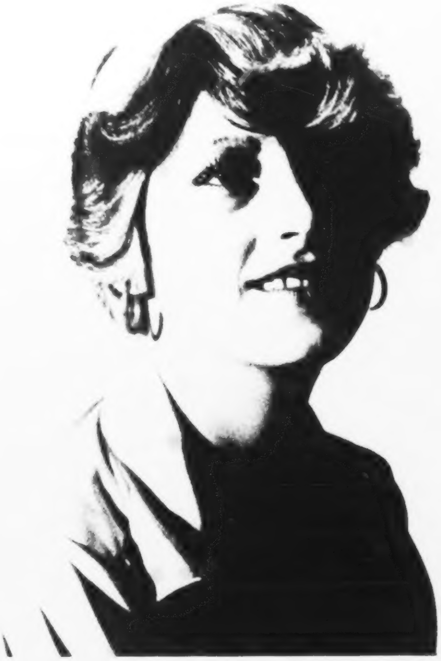


Figure 3-9. Harsh portrait lighting.

light to make your pictures. Umbrellas and reflectors are two more methods you can use to apply light.

Exercises (424):

1. What can you use to increase the efficiency of a light?

2. List three things you can use to make a reflector.

3. What is the general purpose of using a supplementary reflector?

4. If you are going to make an exposure without using reflectors, how should the lights be set up when you make the exposure calculation?

5. Describe an umbrella used for lighting.

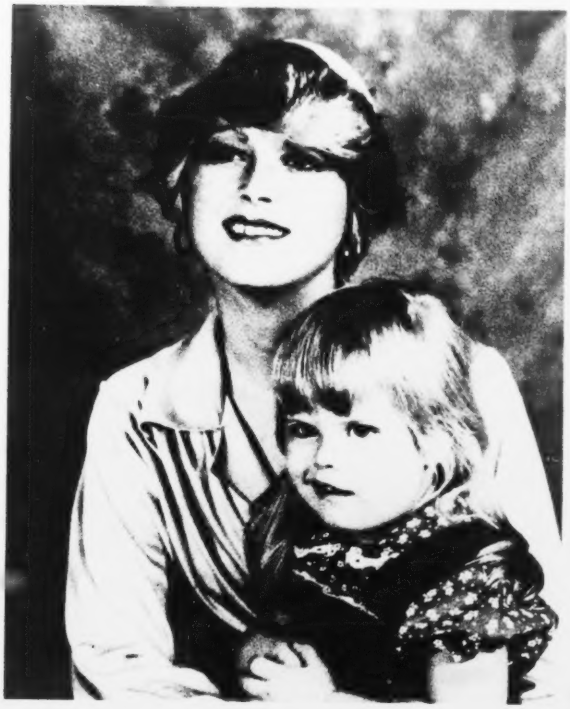


Figure 3-10. Portrait lighting with an umbrella.

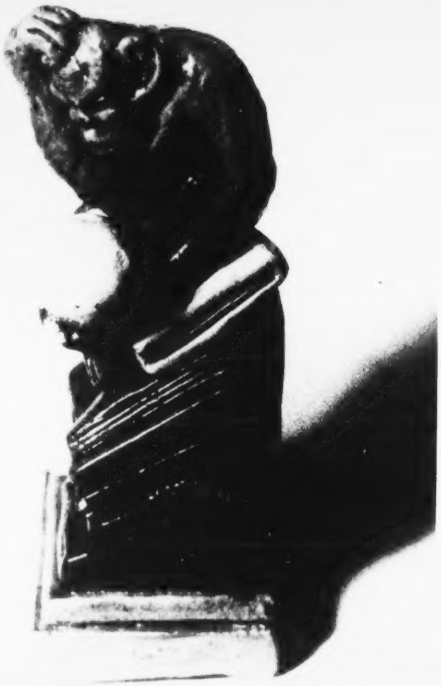


Figure 3-11. Harsh lighting of static object.

6. What would you do if you wanted to diffuse umbrella lighting?

7. Determine your guide number from the following: Flash to subject distance 8 feet. Proper exposure was at f/4. Guide number?

8. Using the guide number in problem 7, what would your f/stop be if the flash to subject distance was 2.9 feet?

3-5. Operator Maintenance

The general is in your studio. You are all set up and ready. You say, "Smile, sir." The expected poof does not happen. You make some half-hearted excuse while mumbling under your breath. You try again. Again no poof. Now you have a real problem. What are you going to do with the general while you troubleshoot your equipment? You might go into your soft-shoe routine, tell some jokes, or talk about the Air Force being a great way of life. All of this will be rather difficult because you usually become quite nervous in times of stress. Blowing an assignment in the presence of a general is positively a time of stress.

How do you prevent these equipment malfunctions? One of the best, simplest, and sure fire ways is to practice operator maintenance.

425. Specify checks to be made on cameras and lighting equipment for proper operator maintenance.

Cameras. You can't produce a picture if your camera doesn't work. So, you need to check to see whether it will work *before* you need it. Some of the areas you need to check are:

- Adjustments. Be sure the front and back adjustments move freely. The tilts, swings, and focus tracks must not catch or stick.
- Lens. Clean the lens with a camel's-hair brush and lens tissue. Fold the tissue over to double thickness; then use a circular motion to wipe the lens. If you use lens cleaning fluid, place a drop or two on the tissue; NOT on the lens.
- Shutter. Make sure the shutter opens and closes when you depress the cable release.
- Miscellaneous. Look for loose nuts, bolts, and screws; tighten them if necessary. Check for broken parts and light leaks; replace or fix as required.

Lighting Equipment. Since you need light to make a photographic exposure you need to check them out, too. The areas of concern are:

- Electrical cords. Make sure there are no bare wires. Check the plugs that go into the wall receptacle and into the flash units for loose prongs or wires.
- Incandescent. Turn on the photofloods to see if they work. If they don't, check the connections and make sure the bulbs are in tightly.
- Electronic flash. Check all connections. Fire the lights to see if they will work. Connect the flash units to the camera and make sure they work when you trip the shutter. Be sure each bulb is seated properly.
- Reflectors. Check to be sure each reflector is attached properly to its lamp or separate stand.
- Miscellaneous. Check for loose nuts, screws, and bolts and tighten them as necessary.

Figure 3-12. Umbrella lighting of static object

Exercises (425):

1. Be sure that the front and back movements of the studio camera move ________.
2. When cleaning a lens, fold the lens tissue to ________ thickness.
3. Check electrical cords for ________ wires.
4. If the photofloods do not come on, you should check the ________ and make sure the ________ are in ________.
5. The electronic flash units should ________ when you ________ the shutter.
6. With a camera or lighting equipment you need to check and tighten loose ________, ________ and ________.

Reproduction Photography

THE TERM "COPYING," as used in photography, means the photographic reproduction of another photograph, drawing, map, chart, or similar flat-plane object. Reproductions of this type have a number of uses. Consider several examples. If a negative is lost or unavailable, a duplicate may be made by copying a print made from the original negative. Valuable documents, if used constantly, soon become worn and illegible; however, by making reproductions through the process of copying, you can preserve the original. On some occasions, it may be desirable to reproduce the subject at a different scale or size; this change, too, can be effected by copying. Again, in some instances, a great quantity of prints from a single negative is sometimes requested with a deadline for delivery. In such cases, duplicate negatives may be made and given to as many printing teams as necessary in order to complete the work in the stipulated time. On other occasions, copying may be used to improve a photographic print. For instance, stains and blemishes clearly detract from the quality of the print. If, however, such a stain or blemish is transparent or translucent, it may be toned down by using a filter that is deeper than the color of the stain.

Every picture which you see in a newspaper, book, or magazine has been copied at least once. Banks make photographic records of checks received. Entire libraries are copied on film that occupies a tiny fraction of the space required for the books. Copying is thus of great importance. To be successful, such copying requires careful work. The problem of copying is complicated by the great variation in the nature of the originals to be reproduced and by the varying conditions under which the work is to be done.

In this chapter we will discuss copying reflective subjects, making scale change provisions, duplicating transparent material, and using specialized copy procedures.

4-1. Copying Reflective Subjects

Subjects to be copied are broadly categorized in two ways: reflective or transparent. Reflective subjects, like photographs, paintings, schematics, and maps, are very common copy subjects. Reflective subjects are so identified because they are copied by reflected light rather than light passing through the subject as is the case with transparencies (e.g., slide copying). Proper copying of reflective subjects (or transparencies) is only achieved by proper lighting, camera operation, filter selection, exposure, and appropriate film/developer combinations. We have discussed camera operation and filters, and we will review particular copy exposure problems in the section on scale changes, so now let us take up the other topics as they relate to copy work.

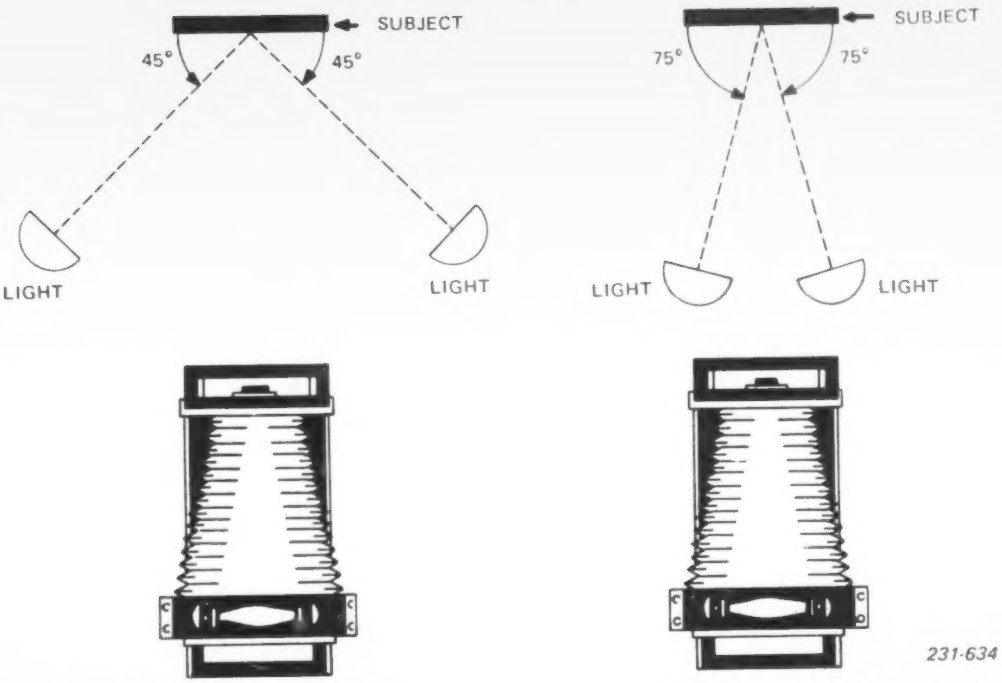
426. Cite techniques used for the correct lighting of reflective copy subjects.

Copy Lighting. You can use practically any type of lighting source when making copies; included are ordinary tungsten lamps, photoflood lamps, flash, fluorescent tubes, daylight, quartz iodine, and mercury vapor systems. Regardless of the type of lights used, the basic requirement for copy lighting is even illumination. Uneven lighting will result in negatives with uneven density, and the production of uniform prints that match a good original print will be impossible. An easy check for evenness of illumination is to place the end of a ruler or similar opaque object against the center of the subject at a slight angle. (Be careful that you do not get your body in the path of the illumination.) Balancing the shadows on each side of the ruler enables you to control the evenness of the intensity. Move either light, as necessary, to equalize the lighting.

Subject material. An important consideration in light-positioning is the subject material. For smooth, glossy surfaces, the lights will provide the best illumination with the least amount of reflection when placed at an angle of approximately 45° to the subject. The lights should be moved more nearly parallel for rough surfaced material. An angle of 75° will minimize texture detail and help assure higher quality reproduction. (See fig. 4-1).

Reflection control. Two conditions generally cause reflections in copy work. One is reflection of the light source; the other is reflections over the entire surface of the copy subject.

Reflections of the light source are caused by light reflections from the camera stand, lensboard, or any



A. SMOOTH SURFACES

B. ROUGH SURFACES

Figure 4-1. Positioning lamps.

other equally shiny object around the copying setup. These reflections usually occur when you are copying glass-covered paintings, glossy photographs, and other smooth surface objects.

The easiest way to eliminate this type of reflection, if changing the position of the lights does not help, is to use a black cloth or sheet of hardboard painted dull black as a shield. By cutting a hole (the size of the lens) in the center of the board and by placing the board over the lens, you can usually eliminate this type of reflection. You may also use a ~~sun~~shade to aid in eliminating stray light rays and reflections. lens

Reflections over the entire surface occur with rough, scratched, crumpled paper prints or paintings with strong brush marks, canvas textures, or cracks, etc. These reflections occur because each high spot in the surface of the original causes a small specular reflection of the light source. Such small reflections cover the surface of the copy with a haze of light which destroys contrast and results in a flat, muddy image. The two methods to subdue or eliminate surface reflections are (1) bounce lighting and (2) polarized lighting.

Bounce lighting may be used as follows: If the ceiling of the copy room is low enough, direct two lamps upward so that the light bounces off the ceiling and spreads a soft, diffused light over the original. If the ceiling is too high, it may be possible for you to use a large white board positioned horizontally over the lights to reflect the light to the subject.

Polarized lighting is a little more complicated than bounce lighting. For one thing, placing a polarizing filter over the lens alone makes little, if any, improvement because the lens axis is at right angles to the subject's surface. But by using a polarized light system, most reflections can be eliminated. To use this system, place a polarizing screen over each lamp and also place a polarizing filter over the lens. By rotating the filter, you can reduce or eliminate all the reflections.

Exercise (426):

1. Complete the following statements on copy lighting.
   a. ____________ type of lighting source can be used in copy work.
   b. To be effective, copy lighting must be _____ .
   c. With glossy surfaces, the lights should be at ______________________ to the subject.
   d. Using a lensshade can cut down ____________ source reflections.
   e. Reflections off a very rough surface can be cut down by using either __________ or ________ lighting.

427. Identify characteristics, problems, and techniques associated with the copying of different types of reflective subjects.

Reflective Copy Subjects. Let us discuss specific problems of copying different types of reflective subjects.

Black-and-white line drawings. There are a number of documents and originals that fall into this category. For example, you may be required to copy such things as maps that are printed in black-and-white, schematic drawings, pages of typed material, recall rosters, and organizational charts.

Generally speaking, a line original has but two tones—black (or a dark shade of gray) and white (or a very light shade of gray). As far as contrast is concerned, these two tones should be separated as much as possible. The net result is a high-contrast negative; and when combined with printing on a high-contrast paper, the high contrast of the original is maintained. Remember, under these high-contrast conditions, film latitude is very short and the exposure is critical. Consequently, if you miss the exposure, you are taking a chance of filling in or obliterating fine lines. To avoid this, you should allow ample exposure but not overexposure of the film.

If the black-and-white material is printed on just one side, it may be backed with white paper to increase the contrast. This is especially true if the original had been printed on rather thin paper, in which case the dark color of the easel may ~~shine-~~ bleed through. If the material being copied has been printed on both sides, such as you might find if you were copying a page from a magazine, the ink from the reverse side may possibly show through. Should you encounter such a situation, it would be wise to back the original being copied with black paper in order to avoid recording the material on the reverse side.

Colored line originals. In general, the technique of copying colored line originals onto black-and-white film is essentially the same technique as that used for copying black-and-white material. Among the colored line subjects which you may be required to copy are maps that have been printed in several colors in order to define different terrain features; drawings that have been printed in colored ink, with the color identifying various mechanical features; and blueprints. The usual problem is to obtain the greatest contrast between the line and the background materials. Typically, it is best to use panchromatic film for this type of copying, since filters are most frequently used to obtain the high degree of contrast that is necessary. For example, when copying a blueprint maximum contrast can be obtained by using a red filter which will cause the blue background of the diagram to appear clear on the negative.

Black-and-white continuous tone originals. The most common black-and-white, continuous tone original that you will be required to copy will undoubtedly be a photographic print. A good copy negative made from such a print should closely resemble the original negative. It should have the same gradation in tones as the original. Accurate rendition of this type of original requires the use of a film with a medium contrast, as well as the correct exposure and development. Obviously, if you underexpose a negative in a camera, you lose shadow detail. The same is true in copying. By the same reasoning, overexposure in either situation causes a blocking of highlight detail.

Very often you may be required to copy old photographs that are wrinkled or creased. These wrinkles or creases generally cause reflections. The print may be flattened out by pressing the print under a piece of heavy glass. You will then have to use the appropriate lighting to reduce reflections off the glass surface.

Ordinarily, if the print is badly soiled, it should be cleaned before copying. If, however, it is a valuable print, you should obtain the best possible copy reproduction before attempting any cleaning. Of course, if damage to the old original is considerable, you obtain the best possible copy; then retouch the resulting print and recopy it.

Stained prints can be copied on panchromatic film. When you do this, use a filter as close as possible to the color of the stain. In fact, for best results, the color of the filter you use should be somewhat deeper than the color of the stain. For example, if a print has a yellow stain, it should be copied on panchromatic film in conjunction with a deep yellow filter.

In contrast with stained prints, copying faded prints is different. For one thing, if the image has turned yellow with age, you must restore its original brilliance. Consequently, you should use a filter which is opposite in color to the faded image. For example, if the image has turned yellowish-brown, you can copy the print on panchromatic film with a blue filter. In such a case, you may find that rather than using panchromatic film, it is simpler to use blue-sensitive film without a filter.

Color continuous tone. Various types of color continuous tone originals may be successfully copied onto black and white. Examples of these include water or oil color paintings, color photographic prints, or magazine illustrations. Typically, you would use panchromatic film of moderate contrast. Filtration may be necessary if you need to achieve contrastier tonal separations.

A soiled color print may be very difficult to clean because of the nature of the dyes that make up the image. You may find that the best way is to copy the soiled print and then retouch the print made from the copy negative. The retouched print then can be copied.

Stained color prints can be copied through the appropriate filter. The filter should be darker than the stain color. One problem is that the filter will affect the other colors of the print.

Exercises (427):

1. Match the copy subject in column A with the appropriate category in column B.

Column A	*Column B*
____ 1. Musical scores.	a. Color continuous tone.
____ 2. Color schematic.	b. Black-and-white line.
____ 3. Black-and-white scenic photograph.	c. Black-and-white continuous tone.
____ 4. Oil painting.	d. Color line.

2. What type of black-and-white film should be used to copy a line drawing? Why?

3. If you have a print that has a green stain, what color filter should you use?

4. If you are copying a page from a magazine, what precaution should you take?

5. What color filter should you use when copying a yellow faded print?

428. Select the appropriate film/developer combination for different types of copy subjects.

The primary consideration for you to think about is the type of original to be copied. You generally have three types of film: panchromatic, orthochromatic, and blue sensitive. These categories are further classified into process, photomechanical, and medium contrast films. Some film manufacturers have coined their own trade names to describe their films. Examples are Kodak Commercial Ortho, Kodak Contrast Process Ortho, GAF Commercial Ortho, and Agfaortho.

Once you have chosen the film, you must use the proper developer. It wouldn't do any good for you to use a high-contrast film and a medium-contrast developer. Table 4-1 shows you the basic guides for film/developer and original combinations.

Film/Developer Combinations for Copy Work. The variety of subjects to be copied are such that no one film can satisfactorily reproduce all of them. Consequently, the selection of a film/developer combination should be governed primarily by the classification of the copy subject. Since the characteristics of film emulsions vary widely, it is important for you to know these differences so that you can choose the proper film for the desired results.

Films designed for copy and reproduction are generally slower than conventional films for general everyday usage. This reduced sensitivity provides good resolving power, maximum definition of subject matter, and greater control of contrast. However, the exposure latitude is shortened, and this creates the need for increased exposure accuracy.

Even the manufacturers, realizing the various sources of illumination, omit any specific film speed rating for photomechanical films. Only a suggested exposure is included with the data charts. Photomechanical film is primarily designed for exactness in image-scale reproduction and consists of a thin base with a very low percentage of shrinkage or stretch during processing. Most frequently used are orthochromatic emulsions, which can be handled under red safelights for identification because the familiar code notches are not included.

To obtain the maximum contrast that these photomechanical films are capable of producing, develop them in a fine-line developer. This solution comes in a two-package "A" and "B" container. Each package of powdered chemicals must be thoroughly dissolved and stored in well-stoppered containers. The working solution consists of equal parts of "A" and "B," which tends to exhaust rapidly due to its high alkaline content, and should be used shortly after preparation is completed. Agitation is recommended during the first 20 seconds, and range of average development is 2 to 4 minutes. Should a substitute solution such as D-19 be used, increase exposure about 25 percent.

Perhaps the one film which could be classed as general purpose for most routine copy in photography is commercial ortho. This emulsion is closely related to Gravure film and provides fine detail plus delicate tone gradations. Landscapes, portraits, machine illustrations, and mechanical parts illustrated in black-and-white are typical subjects for copy using commercial ortho. Ortho is, of course, not suitable for color copy since it is insensitive to red.

Exercise (428):

1. Match the correct film/developer combination listed in column A with the appropriate copy subject listed in column B. Be sure not to use a particular combination more than once.

Column A	*Column B*
____ 1. Process Panchromatic D-19.	a. Color portrait.
____ 2. Medium Contrast Panchromatic DK-50.	b. Organizational chart.
____ 3. Photomechanical Panchromatic/Fineline A&B.	c. Black-and-white portrait.
____ 4. Commercial Ortho DK-50.	d. Color-coded map.
____ 5. Process Panchromatic D-19.	e. Black-and-white schematic.

TABLE 4-1
FILM DEVELOPER COMBINATIONS USED IN COPY PHOTOGRAPHY

FILM DESCRIPTION	SUBJECT CLASSIFICATION	DEVELOPER	RATIO OF DILUTION	TIME 68°F
PROCESS PANCHROMATIC	BLACK & WHITE LINE DRAWINGS	D-19	NONE	6 MIN
PROCESS ORTHOCHROMATIC		D-19	NONE	6 MIN
PHOTOMECHANICAL PANCHROMATIC		FINELINE "A" & "B"	NONE	2-4 MIN
PHOTOMECHANICAL ORTHOCHROMATIC		"A" & "B" FINELINE	NONE	2-4 MIN
PHOTOMECHANICAL PANCHROMATIC	COLOR LINE DRAWINGS	FINELINE "A" & "B"	NONE	2-4 MIN
PROCESS PANCHROMATIC		D-19	NONE	6 MIN
COMMERCIAL ORTHO	BLACK & WHITE CONTINUOUS TONE	DK-50	1:2	6 MIN
MED-CONTRAST PANCHROMATIC		DK-50	1:1	5 MIN
MED-CONTRAST PANCHROMATIC	COLOR CONTINUOUS TONE	DK-50	1:2	6 MIN
MED-CONTRAST ORTHOCHROMATIC	CONTINUOUS & HALF-TONE BLACK & WHITE	DK-50	1:2	6 MIN

231-695

4-2. Scale Change Provisions

The scale of a reproduction is the ratio between any linear dimension of the copy and the related dimension of the original. For example, if an 8 x 10-inch picture is reproduced at half scale (50-percent reduction), the reproduced dimensions on the negative are 4 x 5. Since you will be required to do copy work at other than 1:1 (100 percent), you will need to know how to make appropriate scale changes. In addition, scale changes will involve changes in exposure which you should be well aware of.

NOTE: Fortunately, most copy cameras have calibrated scales which help the operator to achieve proper reproduction ratios without mathematical calculations.

429. Solve a series of scale change and copy exposure problems.

Ratio and Scale. Ratio, scale, and exposure become additional problems peculiar to copy work. Work orders may ask for copy pictures in several different ways. The work order may ask for a 1:2 copy, a 50-percent reduction, or simply ask for a copy to 8- x 10-inch size. No matter how the work order states the requirement, you will have to do some calculations to determine how much bellows extension and how much exposure compensation you need.

Mathematics calculations for bellows extension and subject distance. To get the difference sizes of the copy work, you need to extend or shorten the bellows and increase or decrease the distance from the lens to the subject. Two formulas to determine these distances are:

$$\text{Bellows extension} = \text{FL} \times (\text{scale} + 1)$$
$$\text{Subject distance} = \text{BE} \div \text{scale}$$

Where FL = focal length, scale is the ratio, and BE = bellows extension.

Suppose you need to make a 50-percent reduction while using a 6-inch lens. Substitute your known factors into the formulas:

$$\text{Bellows extension} = 6 \times (.5 + 1)$$
$$\text{Bellows extension} = 6 \times 1.5$$
$$\text{Bellows extension} = 9 \text{ inches}$$

$$\text{Subject distance} = 9 \div .5$$
$$\text{Subject distance} = 18 \text{ inches}$$

You have now determined that to make a copy at 50 percent the original size you need to have 9 inches between the lens and the film plane and 18 inches between the lens and the subject.

We include these formulas to show you the relationship between the bellows extension and the subject distance. Actually you need only to remember the bellows extension calculations.

When you get a request to make a reduction, the simplest way to get the proper subject distance is to measure the subject and its image on the ground glass. For example, suppose you need to make a 50-percent reduction. Measure a straight line on the original. Then with the proper bellows extension, move the copy board or camera until the measured line on the original is one-half as long on the ground glass.

Another method is to place a ruler on the copy board. If the original is to be reproduced at 25 percent, adjust the image on the ground glass until one inch on the ruler is 1/4 inch on the ground glass.

Bellows extension factor. As you lengthen the bellows, the light must travel further to get to the film plane. When this happens,you need to increase the exposure to compensate for this light loss. We have one more formula to use to determine how much exposure compensation is necessary for any given bellows extension. The formula is:

$$\frac{\text{Bellows extension}^2}{\text{Focal length}^2} = \text{bellows extension factor}$$

To make a copy at the same size as the original or 1:1, you need to extend the bellows to two focal lengths. The increased bellows extension causes a loss of light at the film plane and must be accounted for. We call this compensation the bellows extension factor. To figure out how much compensation you need, measure the bellows extension and square the factor, then square the normal focal length and divide that into the square of the bellows extension. The result of that will be your bellows extension factor.

The formula looks less confusing:

$$\frac{\text{Bellows extension}^2}{\text{Focal length}^2} = \text{bellows extension factor}$$

Solve a problem when the bellows extension is 8 inches and the focal length is 4 inches. Go through the formula, putting in the known factors.

$$\frac{\text{Bellows extension}^2(8^2)}{\text{Focal length}^2(4^2)} = \text{bellows extension factor}$$

$$\frac{64}{16} = 4$$

What would be the bellows extension and bellows extension factor needed to copy an original using a 4-inch lens when the original is to be reduced in size by 25%? Since reduction is 25%, scale is 75% (of the original). Using the formula for bellows extension we find:

$$\text{BE} = 4 \times (.75 = 1)$$
$$\text{BE} = 4 \times 1.75$$
$$\text{BE} = 7 \text{ inches}$$

Now that we know what bellows extension is needed, we can find the bellows extension factor (BEF), by doing the following:

$$\text{BEF} = \frac{\text{BE}^2}{\text{FL}^2}$$

$$\text{BEF} = \frac{49}{16}$$

$$\text{BEF} = 3$$

We have now determined that we must increase the originally computed exposure by three times. The exposure factor is used the same way a filter factor is used, as discussed in Volume 2. For example, if the original exposure was f/8 at 4 seconds, you simply multiply the expsoure time by the bellows extension factor. 4 × 3 = 12 seconds.

Now that we have gone through the hard part of exposure compensation, we will show you the easy way. A hand-held light meter can be used effectively to determine exposure compensation for close-up photography. Either an incident or a reflected light meter can be used for this purpose. However, an incident reading is best when photographing small objects. To use this exposure determining method, you must know the focal length in inches of the lens you are using. Let's suppose that you are using a 100-mm lens. Convert 100 mm to inches by multiplying by 0.04—100 × 0.04 = 4 inches. First take your light meter reading. As an example, if your meter reading is 1/60 second at f/11, your next step is to consider the f/stop dial on your light meter as if it were calibrated in inches, *example:* 4/4 (4 inches), f/5.6 (5.6 inches), etc. Rotate the f/stop dial on the light meter so that f/4 (4 inches) lines up with 1/60 second.

Now measure your lens-to-film plane distance. If the distance is 8 inches, read the new exposure time opposite f/8 (8 inches). In this instance the new exposure time would be 1/15 second at f/11, which would be two additional f/stops from the light meter reading.

Exercises (429):

1. Why do you need to increase the exposure when you lengthen the bellows?

2. Determine the bellows extension and the new exposure if: focal length is 6 inches, reduction is 50 percent, and original exposure was f/8 at 1/2 second.

3. Suppose you are using a 12-inch lens, making a 25-percent reduction. Calculate the bellows extension, the bellows extension factor, and your new shutter speed if original exposure was f/11 at 1/2 second.

4. If a measured line on the original was 4 inches, how long should it be on the ground glass if you were making a 1:1 reproduction?

4-3. Processing Copy Film

All the exposure compensation formulas in the world will not help you get the product finished unless you process the film. You cannot process the film until you have learned the proper processing procedures. We have mentioned film processing in previous sections but have not covered it too explicitly. In this section we will get more involved with processing.

430. Specify procedures for processing copy film.

Developers. There are so many different types of developers that we could not possibly include them all in this section. When you need to select a particular developer, you need to know its basic characteristics and purpose. When you need this information, you should read the *Photo Lab Index*, published by Morgan and Morgan or the *Photographic Lab Handbook*, published by Amphoto.

The object in copy work is to get as good a reproduction as possible. So, if you know you are using a fine-grain, high-contrast film, you should use a compatible developer. Kodak D-19 or GAF 72 are two such developers. That is, they are both fine-grain, high-contrast developers.

Processing. Processing copy film is not much different from processing any other type of film. You will be processing a very few sheets of film at one time, so it will probably be easier. And since copy film is generally very slow, you can process it under safelight conditions. This is called processing by inspection.

To process by inspection you must first know what color(s) of light the film is sensitive to. If the film is sensitive only to blue, you could use a red, green, or yellow safelight filter. The data sheet that is packed with the film usually tells you what safelight filter you can use, how strong the light can be, how long you may have it on, and how far away the light must be from the film.

After you have made the exposure and installed the proper safelight filter, you should be ready to process the film. Generally, you process copy film by inspection throughout the developing step. Since processing by inspection is learned by experience, it is very difficult to teach it in a CDC. We have included some of the major things to look for as follows:

- Highlights. The darkest part of the negative should be allowed to develop to the darkest density possible.
- Shadows. Process the film until the lightest parts of the image just begin to pick up density.
- Lines. You must watch the density build up around the lines. The lines must remain clear. Stop development before the lines pick up density.

Positive Materials. Occasionally you will have to make positive reproductions. Such things as vu-graphs, charts, and large transparencies will be requested from your lab. These are used for training and briefings. If you get such a request, you will need to know how to produce them. The easiest method is to use positive film.

Positive film is very slow and can be handled under safelight conditions. It can be used as copy film exposed in the copy camera, or it can be exposed using a projection or contact printer. It generally has a short exposure latitude and fine grain.

You must read the data sheet to see how to expose and process these positive materials. Some are automatic and can be developed in ordinary black-and-white developers. Others are called reversal films and must be developed in reversal solutions.

The reversal films produce a positive image by way of reversal processing. When the film is exposed, all of the silver is not used to record the camera image. This first exposure is processed in normal developers. The remaining silver is then exposed, developed, bleached, and fixed. The result is a positive image.

Exercise (430):

1. Indicate which of the following statements are true:

____ a. There are only a very few developers to choose from when processing copy film.

____ b. Generally, copy film can be handled under safelights.

____ c. You can find safelight recommendations in the film data sheet.

____ d. The lines of a copy negative must remain clear.

____ e. Positive film is a fast, coarse-grain film.

____ f. Reversal film must be developed twice.

4-4. Finishing Copy Film

After you have exposed, processed, and dried your copy film, you must complete an operation called finishing. Finishing is the art of putting the final touches on your product. As a 3-level photographer, your finishing work will be limited to the area we call opaquing.

431. Specify procedures and techniques related to spotting and opaquing copy film.

As you recall from Volume 2, an opaque medium does not transmit any light. When you produce a copy of a line drawing, you want the lines to stand out and the background to be white in the final print. In other words, you want the background to be opaque.

Some of the things that keep the background from being opaque are dust, lint, hair, and scratches. When you print the negative, these light areas allow light to pass through to the print. This results in dark spots on the print which are unacceptable. The elimination of these small spots on the negative is called spotting.

Spotting. Equipment used for spotting includes mapping pen, red dye, brush, and opaque. The pen and dye are especially satisfactory for spotting the small areas, and the brush can be used with either the dye or the opaque for the larger areas. The use of the brush and the opaque is not very satisfactory for the small areas. Because of the flexibility of the brush, you may easily opaque too large an area. Opaque dries rapidly on the tip of a finely pointed brush—often before the brush can make contact with the negative.

Place the negative on the retouching easel, printer, or plotting table with the emulsion side of the negative toward the glass. Dip the mapping pen in the dye. Using good magnification, lightly touch the spot on the back side of the negative. With care, you can confine the dye to the spot without spreading over the surrounding area. Use extreme care in keeping the point clean if fine work is to be done quickly. You will notice that the penpoint has a tendency to pick up small pieces of gelatin from the negative.

Because pinholes are actually small holes in the emulsion, they cannt be spotted on the emulsion side of the negative. The capillary action draws the dye to the sides of the hole, and the pinhole remains uncovered. At best, a pinhole is very difficult to correct on a negative; sometimes it can be successfully done on the back of the negative with dye.

Opaquing. An example of opaquing is the elimination of an objectionable background. Covering the undesirable portion with a light-resistant dye or opaque compound eliminates it from the print. When such a procedure is used, the blocked portion of the print appears white.

Begin by placing the negative on a well-illuminated surface, such as a printer, retouching easel, or plotting table. The negative may be blocked on either side or both sides if necessary. It is best, however, to block on the base side of the negative. This avoids possible scratching of the emulsion.

Saturate a cotton swab to about half its length with 1A red dye. Follow the outline of the image, using short, side-to-side strokes. Work slowly, allowing sufficient time for the gelatin to become saturated with the dye. Experience and practice make it comparatively easy to follow the outline accurately. Use the swab the same way you would use a pencil or crayon. It may be necessary to block on both sides of the negative if the area to be blocked is very thin and the image quite dense. This would be an exceptional case, however. Narrow areas may be filled in with a mapping pen. One common practice is to outline the subject with a mapping pen and block the remainder of the negative with a brush. Normally, we do not completely reverse a background from black to white.

Dye blocking does not crack or flake off the negative. Errors made may be removed by lightly wiping the area with a cotton swab and clear water. If the dye is not completely removed with water, use a 10-percent solution of sodium sulfite. All of the dye may be removed by soaking the negative in a tray of such a solution. With moderate agitation, the red color and the resulting yellow stain both disappear. Wash the negative in running water for 5 minutes and then dry it. You may then repeat the blocking process if you desire.

Opaque may also be used for the blocking process. Although it may have a tendency to crack and flake, it does have the advantage of complete blocking with a single application. Furthermore, it may be used in a rather thick consistency and as such does not tend to run as the red dye does. It is exceptionally good for following along the edges of objects.

As with any new procedure, spotting and opaquing will become easier as you practice. The key words are patience and practice.

Exercises (431):

1. In high-contrast line drawings, how should the background appear in the print?

2. List three things that prevent the background from being opaque in the negative.

3. Define "spotting."

4. On which side of the negative should you apply the spotting fluid?

5. When would you block on both sides of the negative?

4-5. Operator Maintenance

As with any other photo equipment, you must keep copy equipment operating properly. The best way to be sure your equipment will work is to practice good operator maintenance.

432. Specify procedures for proper operator maintenance on copy equipment.

Operator maintenance in the copy room is really no more than commonsense houskeeping. You must keep everything clean and in its proper place. Remember to clean the room, camera, copy board glass, and work areas.

Room. General housekeeping is the key word in the copy room. Clean the benches, floors, and shelves. This is not really operator maintenance, but it will reduce the dust that may cause defects in your finished film.

Camera. Check to see that all of the camera controls work properly. Clean the lens with a camel's-hair brush and lens tissue. Check for light leaks in the bellows. Clean the bellows inside and out with a slightly damp cloth. Clean, oil-free compressed air may be used to blow dust out of the bellows. A very gentle stream of air is best to avoid damage to the bellows.

Check the ground glass back for dirt and cracks. Check and clean the area where the film rests during exposure. Some copy cameras have a vacuum back that keeps the film in place. Check that the vacuum holes are not clogged with dirt or pieces of film.

The copy board should be cleaned. Also, clean the glass that covers the copy board. Check that the latches are working properly.

Lights. Make sure your lights are working properly. If not, fix or replace as required. Remove the dust from the lights and reflectors. Check for frayed electrical cords and replace them if necessary.

Processing Room. Clean the processing room as necessary. Check for leaking water lines and have them repaired. Look for unsafe electrical conditions, such as loose, frayed and improperly secured electric cords.

Make sure your safelight filters are not broken or faded. Replace them as necessary.

You are not expected to be an expert in photo equipment repair, but you do need to know which items will not or cannot work. Identify the ones you cannot fix and have the repair people fix them.

Exercise (432):

1. Complete the following statements by filling in the missing terms or phrases:
   a. Operator maintenance in the copy room is no more than __________ __________.
   b. Cleaning the copy area will reduce __________ that may cause __________ in your finished product.
   c. Clean the lens with a __________ __________ __________ and __________ __________.
   d. You can clean the inside of the copy camera with __________, __________, compressed air.
   e. You must clean the __________ that covers the copy board.
   f. Remove the dust from the __________ and reflectors.
   g. Safelight filters should be checked to see if they are __________ or __________.

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TO 00-35D-54, *USAF Materiel Deficiency Reporting and Investigating System.*

AFR 36-93, *Official Photographs.*

AFR 39-11, *Airman Assignments.*

AFR 211-29, *Passports.*

NOTE: None of the items listed in the bibliography above are available through ECI. If you cannot borrow them from local sources, such as your base library, or local library, you may request one item at a time on a loan basis from the AU Library, Maxwell AFB AL 36112, ATTN: ECI Bibliographic Assistant. However, the AU Library generally lends only *books* and a limited number of *AFMs*. TOs, classified publications, and other types of publications are *not* available. Refer to current indexes for the latest revisions of the changes to the official publications listed in the bibliography.

Answers for Exercises

CHAPTER 1

Reference:

400 – 1. Without a strong point of interest the viewer will not understand the purpose of the photograph.

400 – 2. The three techniques you can use to simplify a photograph are moving closer to the subject; choosing a plain background; and letting the light emphasize the subject.

400 – 3. A high horizon line can give the appearance of depth and distance.

400 – 4. The purpose of a leading line is to guide the viewer's eye to the subject.

400 – 5. The subject will appear pretty sharp while the background will be blurred.

400 – 6. Haze in a scenic will given a feeling of depth.

400 – 7. The appropriate use of a filter can prevent the blending of tones that obscure detail.

401 – 1. (1) Diminution is the characteristic of objects in the background looking smaller than those in the foreground even though they are of the same size.

(2) Foreshortening is a form of distortion whereby foreground objects appear to be disproportionally large.

401 – 2. Foreshortening can be prevented in portrait work by maintaining a reasonable shooting distance and using a long focal length to achieve the appropriate image size.

401 – 3. A view camera with its many adjustments can achieve distortion free images to a degree not possible with other types of cameras.

401 – 4. Perspective is the impression of depth when a three-dimensional scene is represented on a two-dimensional photograph.

402 – 1. a. Camera angle is a key factor in how the subject will look. By changing the camera angle, it is possible to have the subject look more imposing or distinctive. It is therefore a good idea to check out the subject from as many angles as possible when you are shooting.

b. All elements in the picture must contribute to the whole. Whenever possible the photographer should adjust the various elements until they make an effective arrangement. When the subject cannot be moved, the photographer must rely on camera angle to make an effective composition.

c. Equipment can extend your picture possibilities. Lenses, filters, and lighting equipment can help you achieve the visual result that you want.

d. The point of focus and the degree of depth of field will determine what the viewer will see sharply. This will, in turn, determine where the picture emphasis will be.

e. The tones of gray and the contrast relationship between them will affect how the viewer sees the picture.

CHAPTER 2

403 – 1. Some of the things you need to find out are: whom do you report to, will transportation be provided, will you have help, what is the suspense, do you need proofs, and will you have room to move about?

403 – 2. AF Form 833.

404 – 1. Three factors you must consider are product desired, shooting conditions, and time requirement. The product desired will help you determine the type of film, processing, printing, and choice of camera. Shooting conditions will also determine the type of camera and particularly the accessories you will need. Time requirements will often call for a particular type of material or limit the number of shots.

405 – 1. A visual check gives you a good indication of the condition and usability of a piece of equipment.

405 – 2. By performing operational checks you better insure that you will not experience a malfunction.

405 – 3. Preventive maintenance prevents excess wear or damage to equipment.

405 – 4. Three preventive techniques are making adjustments, cleaning, and lubrication. Making adjustments is tuning a piece of equipment so that it conforms to specifications. Cleaning will help keep down dust or dried chemicals that can ruin any step in the photographic process. Proper lubrication will prevent wear.

405 – 5. Limitations on operator maintenance are set out by applicable regulations and technical orders. They are also affected by the availability of maintenance personnel and maintenance beyond the lab.

406 – 1.
a. Lightproof.
b. Lightproof; clean; dust free.
c. Facing.
d. Unexposed.
e. 12; 16.
f. Film pack adapter.
g. Camera.
h. Clean.
i. Rollers; bars; guide.

407 – 1. Develop the idea, research and prepare the script.

407 – 2. Keep the idea within well-defined limits.

407a – 1. Obtain all data relative to the job. Start the layout with a number of small thumbnail sketches, keeping in mind where you will place the lead and supporting photographs. Once a rough layout has been established, coordinate with the editor to resolve any problems.

407a – 2. The editor and the photographer.

408 – 1.
a. False.
b. True.
c. True.
d. False.
e. True.
f. False.
g. False.
h. True.

409 – 1. Preparation.
409 – 2. 35-mm reflex.
409 – 3. Using a fast shutter speed and panning.
409 – 4. Fast.
409 – 5. No.

410 – 1.
a. Uncontrolled.
b. Flash.

c. Film
d. Overall
e. Portraits of personnel involved.

411 - 1. a. Improvise
b. Size, group.
c. Camera, camera.
d. As few, story.
e. Action.

412 - 1. Spot news events are those events that happen right now. They must be photographed and reported immediately.
412 - 2. Preparation for spot news is limited to making sure you are always ready.

413 - 1. The recipient is the most important element in an award ceremony.
413 - 2. If you cannot control the actual ceremony you may have to stage it.
413 - 3. The certificate should be held so that it can be seen.
413 - 4. Plain.
413 - 5. Use large chevrons or insignia.
413 - 6. The reenlistee.
413 - 7. Nearly anything you do to avoid the "grip and grin" syndrome will add life to your awards and presentations photographs. Examples are: take the photograph at the job site; show the benefits of reenlisting; or show the recipient at work.

414 - 1. 1:1.
414 - 2. An extension tube is a rigid tube which fits between the camera body and the lens. The tube changes the effective focal length of the lens to a given degree. A bellows is flexible and may be racked in and out until the image size is the one that is desired. A bellows is therefore more flexible than an extension tube.
414 - 3. Depth of field is limited because the lens-to-subject distance is so close. In addition, a wide open aperture setting is often required for exposure reasons. This, too, limits the amount of depth of field.
414 - 4. A tripod is essential to insure a very steady camera. Any camera movement would be greatly enhanced in close-up work due to the magnifications involved.
414 - 5. 81 times the given reading ($EF = (M + 1)^2$

$$EF = (8 + 1)^2$$
$$EF = 9$$
$$EF = 81$$

414 - 6. A ring light is effective because it gives very even, flat lighting.

415 - 1. By bringing the defective part to the lab, you will have a greater choice of equipment, background material, and lighting.
415 - 2. Normally, you want to use the finest grain film that you can to insure maximum detail.
415 - 3. A copy camera is ideal for photographing a circuit board.
415 - 4. Chalk is useful in making cracks stand out on a black surface.
415 - 5. Even lighting is used to insure maximum detail.
415 - 6. TO 00-35D-54 is the main TO to consult in regard to MDR work.

416 - 1. a. False
b. False
c. True
d. True
e. True
f. False
g. True
h. True
416 - 2. A camera used for architectural photography should have a long bellows extension; vertical and horizontal swing adjustments on the back; tilting, rising, shifting front; and both long and short focal length lenses.
416 - 3. Avoid totally flat lighting such as an overcast day and light that comes from directly behind you.
416 - 4. You must use long exposures.
416 - 5. (1) Rising, falling, and sliding movements control the position of the image, (2) vertical tilt and horizontal swing of the back control the shape of the image, and (3) vertical and horizontal swing of the front controls focus.

417 - 1. Crash or accident photographs help investigators in solving the cause of the incident.
417 - 2. Color may indicate a cause not shown in black and white. For example, colors may indicate the degree of heat that was generated during the incident.
417 - 3. A photographer must not weaken in the face of the tragedy of an accident or crash. He must concentrate on getting the pictures regardless of the hardships that surround him. To do otherwise would make him a problem for the rescue forces.
417 - 4. Crash information can only be released to the official authorities who have a need to know.
417 - 5. Flash may create a fire hazard.
417 - 6. (1) General views of the areas involved, (2) close-up photographs of important details, (3) photographs of specific parts, (4) marks left on the ground, and (5) views that show damage to other property.
417 - 7. Vehicle number; make, model, and year of the vehicle; tag number and State.

418 - 1. a. Airman Jones did not use proper identification lighting. Identification lighting should show the subject without any glamorizing.
b. Sergeant Smith acted properly. When at the scene, you should never move anything.
c. Amn White acted properly. Take enough photos to show the entire scene.

419 - 1. Carry a camera so that you cannot drop it.
419 - 2. Heat may fog the film in the camera and camera case. It may also cause lens elements to separate.
419 - 3. Humidity may cause fungus to grow between lens elements. It also allows mildew to grow on bellows, bodies, and cases. High humidity may also promote corrosion.
419 - 4. If your camera gets wet you should remove all moisture from the exterior. Then remove the lens and open the camera back to check the interior for moisture. If moisture is in the interior, have a repair person clean the camera.
419 - 5. Eyeglass tissue contains silicones which can damage the coating on camera lenses.
419 - 6. Check lens shades, retaining rings, and the interior of the camera for places that the black paint has been chipped off. If you find shiny spots, apply black paint.
419 - 7. Forming the capacitor allows it to receive and hold a full charge.
419 - 8. Whenever a camera is not in actual use, you should cover the lens with a lenscap and put the camera in a ready case or its carrying case.
419 - 9. Before each assignment you should perform an operational check.
419 - 10. Lens cleaning fluid applied directly to the lens can seep past the front element and cause interior damage.
419 - 11. The shutter should be at its slowest speed.

CHAPTER 3

420 - 1. A personality portrait should highlight the individual. It is more than a record shot and is often used to highlight the individual's accomplishments.
420 - 2. The three categories are personality portraits, keyman, and officer portraits.
420 - 3. Only by keeping up with AFR 36-93 can you be sure that your portraits will conform with the regulation.
420 - 4. You have to exercise tact because you will often have to advise an officer regarding his appearance in terms of conformance with AFR 36-93.

421 - 1. a. Retouched, enlarged
b. Freeze

c Eyes.
d Limited.
e Upper chest.
f 6
g One
h Modeling
i Toward
j Away
k 3:1.
l Lighting ratio
m Diffuse
n Barn doors; head screen.
o 8 feet

422 - 1 To portray a likeness of the person so that identification is possible.
422 - 2 Department of State.
422 - 3 The image of the subject's head may be no smaller than 1 inch. The overall dimension of the passport picture must be 2 x 2 inches.
422 - 4 Flat lighting.
422 - 5 An identification or passport picture must portray the subject as he is. You should not glamorize the photo because you will defeat the purpose of identification photography.

423 - 1 AFR 39-11.
423 - 2 45°, flat lighting.
423 - 3 The feet are sometimes overlooked.
423 - 4 You may have to move the background light to the side of the subject. You may also have to use two background lights.
423 - 5 You should have even lighting from the floor to the top of the subject.
423 - 6 The children should receive the same illumination as the parents.
423 - 7 Distractions to look for are lights, cords, and glare.
423 - 8 You should focus on the subject's eyes.

424 - 1 Use a reflector to increase the efficiency of a light.
424 - 2 Cardboard, paper, handkerchief, or aluminum foil.
424 - 3 The purpose of a supplementary reflector is to direct light into the subject without using additional lights.
424 - 4 Set up the lights without reflectors to take the exposure reading.
424 - 5 Umbrellas are light reflectors. They are generally shaped like an umbrella. They are parabolic, spherical, or conical in shape.
424 - 6 You could bounce the light from the umbrella onto another reflector.
424 - 7 32
424 - 8 f/11

425 - 1 Freely
425 - 2 Double
425 - 3 Bare
425 - 4 Connections, bulbs, tightly
425 - 5 Work, trip
425 - 6 Nuts, screws, bolts

CHAPTER 4

426 - 1 a Any
b Even
c 45
d Light
e Bounce, polarized

427 - 1 1 b
2 d
3 c
4 a
427 - 2 You need to use high-contrast film. High-contrast film is necessary to maintain maximum separation between the white background and the black lines of the line subject.
427 - 3 A dark green filter.
427 - 4 When copying a magazine page you should back it with black paper so that the lettering on the back side does not show through.
427 - 5 A blue filter.

428 - 1 1. e.
2. a.
3. b.
4. c.
5. d.

429 - 1 As you lengthen the bellows, the light must travel farther. The farther it travels the less intense it is, and therefore you must increase the exposure.
429 - 2 Bellows extension = FL × (scale + 1)
$BE = 6 \times (.5 + 1)$
$BE = 9$ inches

$$\text{Bellows extension factor} = \frac{BE^2}{FL^2}$$

$$\text{Bellows extension factor} = \frac{9^2}{6^2} = \frac{81}{36}$$

Bellows extension factor = 2.25
New exposure = 1/2 × 2.25
New exposure = f/8 at 1/2 (1 1/5 second)
429 - 3 Bellows extension = FL × (scale + 1)
$BE = 12 \times (.75 + 1)$
$BE = 21$ inches

$$\text{Bellows extension factor} = \frac{BE^2}{FL^2}$$

$$\text{Bellows extension factor} = \frac{21^2}{12^2} = \frac{441}{144}$$

Bellows extension factor = 3
New exposure = f/11 at 1.5 seconds
429 - 4 4 inches

430 - 1 a False
b True
c True
d True
e False
f True

431 - 1 The background in the print should be white.
431 - 2 Dust, lint, hair, or scratches.
431 - 3 Elimination of small transparent defects in a negative is called spotting.
431 - 4 Base side
431 - 5 You may have to block on both sides of the negative if the area to be blocked is very thin and the surrounding areas are very dense.

432 - 1 a Commonsense housekeeping
b Dust, defects
c Camel's-hair brush, lens tissue
d Clean, oil-free
e Glass
f Lights
g Broken, faded

227

BEST COPY AVAILABLE

S T O P - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE
23132 03 22

PHOTOGRAPHIC CAMERA ASSIGNMENTS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover your answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you have to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If mandatorily enrolled student, process questions or comments through your unit trainer or OJT supervisor. If voluntarily enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #2 black lead pencil.

NOTE: NUMBERED LEARNING OBJECTIVE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE. In parenthesis after each item number on the VRE is the Learning Objective Number where the answer to that item can be located. When answering the items on the VRE, refer to the Learning Objectives indicated by these Numbers. The VRE results will be sent to you on a postcard which will list the actual VRE items you missed. Go to the VRE booklet and locate the Learning Objective Numbers for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

228

MULTIPLE CHOICE

1. (400) To use the golden mean rule in photography, the format is divided into

   a. halves vertically.
   b. thirds horizontally.
   c. halves horizontally and vertically.
   d. thirds horizontally and vertically.

2. (400) A photograph of a subject taken with an archway in the foreground is an example of the use of what element of composition?

   a. Framing.
   b. Balance.
   c. Leading line.
   d. Golden mean.

3. (400) When exercising foreground control the foreground should be

   a. eliminated.
   b. out of focus.
   c. in focus.
   d. lighter than the background.

4. (401) The problem of foreshortening can be corrected by using what lenses?

   a. Macro.
   b. Normal.
   c. Telephoto.
   d. Wide-angle.

5. (401) How can the perspective of a scene be altered?

   a. Change lenses.
   b. Move the camera.
   c. Change film size.
   d. Stop down the lens.

6. (402) Which one of the following camera angles would make a subject more imposing?

   a. Low camera angle.
   b. High camera angle.
   c. Oblique camera angle.
   d. Front camera angle.

7. (403) In order for a photographer to be sure that he will have the necessary equipment to perform a photographic assignment he should

   a. coordinate with the requestor.
   b. ask a supervisor.
   c. read information on AF Form 833.
   d. always carry a complete complement of equipment.

8. (404) What type(s) of film should be used when both black and white color prints are required?

   a. Color slide film only.
   b. Color negative film only.
   c. Black and white panchromatic and color slide film.
   d. Black and white panchromatic and color negative film only.

9. (404) What type of camera would be best to use to cover an aircraft accident?

a. A news camera.	c. A 35mm SLR camera.
b. A press camera.	d. A 35mm RF camera.

10. (405) The three general categories of operator preventative maintenance are

a. adjustments, cleaning, and lubrication.
b. operational checks, visual checks, and cleaning.
c. operational checks, visual checks and lubrication.
d. visual checks, adjustments and lubrication.

11. (406) What is the best method of determining the emulsion side of sheet film when working under darkroom conditions?

a. Feel the film surface.
b. Locate the notching code.
c. Feel the direction of curl of the film.
d. Remove one sheet of film from the box and turn on the light.

12. (407) Which point below is the most important to remember when developing an idea for a picture story?

a. Limit your idea for the picture story.
b. Decide on the number of photographs to be taken.
c. Select an idea that appeals to Air Force personnel.
d. Limit the amount of equipment to be taken on the assignment.

13. (408) The verb form in the first sentence of a caption is usually in the

a. past tense.	c. present tense.
b. future tense.	d. past or future tense.

14. (408) In a photographic caption, persons in the photograph should always be identified

a. at the end of the caption.
b. as soon as possible in the caption.
c. in sequence from left to right.
d. by contrast.

15. (409) What type of camera would be best for covering a sports assignment?

a. A polaroid camera.
b. A 4 X 5 press camera.
c. A 35mm single lens camera.
d. A 2 1/4 X 2 1/4 twin lens reflex camera.

16. (409) When photographing action, which of the following subject factors must be considered?

a. Height and width.
b. Angle and width.
c. Speed and angle.
d. Speed and width.

17. (409) Which of the following subject action directions would require the fastest shutter speed?

a. The action is moving at a right angle to the camera.
b. The action is moving directly towards the camera.
c. The action is moving at an oblique angle to the camera.
d. The action is moving directly away from the camera.

18. (410) Which of the following items of photographic equipment is (are) not carried on a combat assignment?

a. A tool kit.
b. An electronic flash.
c. Telephoto lenses.
d. Wide-angle lenses.

19. (411) Which of the following rules applies when photographing groups?

a. The group should be static.
b. Only the main subject should show action.
c. Everyone in the group should show action.
d. Showing action is unimportant when photographing groups.

20. (412) Which of the following photographic assignments would be classified as spot news?

a. An airmen being awarded the Air Force Commendation Medal.
b. Photographs for a (UMR) Unsatisfactory Materials Report.
c. Photographs of base fire fighting personnel controlling a fire for training purposes.
d. Photographs of a U.S. Senator touring your base.

21. (413) Which of the following persons should be readily identifiable in an awards photograph?

a. The presentor.
b. The recipient's spouse.
c. The recipient.
d. The recipient's supervisor.

22. (413) Which of the following is a technique for improving an awards presentation photograph?

a. Make sure everyone is looking at the camera.
b. Place the particpants close to one another.
c. Place the participants at a normal conversation distance from one another.
d. Do not include the recipient's family or supervisor in the photograph.

23. (414) A camera equipped with a bellows that is capable of extending to twice the focal length of the normal lens can produce what maximum ratio of reproduction?

a. 1:1.
b. 1:2.
c. 1:3.
d. 1:4.

24. (414) Which of the following small cameras is readily adaptable for close-up photography?

a. A 35mm rangefinder camera.
b. A 35mm single-lens-reflex camera.
c. A 120 rangefinder camera.
d. A 120 twin-lens-reflex camera.

25. (414) Which of the following lighting setups should be used to bring out texture in close-up photography?

a. Ringlight.
b. Front lighting.
c. Side lighting.
d. Back lighting.

26. (415) What are the basic type(s) of photographs that are needed to adequately cover an MDR assignment?

a. Close-up only.
b. Medium and close-up.
c. Long and close-up.
d. Long, medium, and close-up.

27. (415) A 35mm camera system is generally not suitable for MDR photography because

a. of the small negative size.
b. it cannot be attached to a tripod.
c. interchangeable lenses are not available.
d. such cameras require elaborate lighting setups.

28. (416) Which one of the following is the least important consideration to be given to a camera that is going to be used for outdoor architechtural photography?

a. A means for attaching to a tripod.
b. A long bellows extension.
c. Vertical and horizontal swings.
d. A mechanism for flash sychronization.

29. (419) When painting with light, you should

a. open the doors and blinds to give even illumination.
b. use a fast shutter speed.
c. hold the light steady at each important area to be photographed.
d. keep the light in constant motion.

30. (417) The main purpose of aircraft and ground accident photography is to

a. provide material for Safety Magazine.
b. furnish support in civil lawsuits.
c. produce safety campaign material.
d. help investigating personnel.

31. (418) Photographs of a crime scene should

a. include all aspects of the scene including the body and suspect.
b. provide views as seen by an average observer.
c. be captioned with date, time, and suspect's name.
d. show the entire scene in one shot.

32. (418) If you need to produce photographs of a body at a homicide scene, what camera position should you use?

a. Point the camera down from a normal standing position.
b. Position the camera level with the body.
c. Shoot all of the photos from a position at the victim's feet.
d. Shoot all of your photographs at a right angle to the body.

33. (419) When you need to store a camera for a long period of time, you should

a. wrap the camera lens and body in plastic bags.
b. completely disassemble the camera and oil each moving part.
c. pack a dehydrating agent inside the storage case.
d. compress the bellows and cock the shutter.

34. (419) Which one of the following statements is not true regarding camera operator maintenance?

a. The first step in cleaning a camera is to remove all dust and dirt.
b. For stubborn smudges on a lens you may apply a few drops of cleaning fluid to the lens.
c. You should never use eyeglass cleaning tissue to clean a camera lens.
d. You can reduce the possibility of mechanical flare by applying black paint to shiny spots on the interior of the camera.

35. (420) Which Air Force regulation gives you guidelines for producing official portraits of officers?

a. AFR 36-93.
b. AFR 39-11.
c. AFR 205-1.
d. AFR 211-29.

36. (420) When taking official portraits the height of the camera should be approximately

a. even with the background light.
b. level with the officer's eyes.
c. about 5 feet high.
d. shoulder high to the photographer.

37. (421) What is the single most important principle in portrait lighting?

a. There should be one background light.
b. The main light should be on the subjects good side.
c. The background should receive twice as much light as the subject.
d. There should be only one dominant light source.

38. (421) The light that is located higher than the subject's head and at a 45° angle to one side of the camera-subject axis is called the

a. hair light.
b. key light.
c. main light.
d. fill-in light.

39. (422) Which one of the following procedures should you use to ensure the image of the subject's head is the right size when taking passport photos?

a. Mark the position of the camera so it will always be the same distance from the subject.
b. Place the studio seat or bench at a distance from the camera equal to four times the bellows extension.
c. Place grease pencil marks on the lens to show how large the subject's head should be on the ground glass.
d. Draw lines on the ground glass to show the maximum and minimum head size measurements.

40. (422) Which of the following statements is true regarding passport photos?

a. Include the applicant and spouse in each passport photo.
b. The subject should not be allowed to smile.
c. The subject must be shown in a front, full-face view.
d. Passports are printed on double-weight glossy paper.

41. (423) If you have children and parents in a group how much light should the children receive?

a. Twice the amount of that falling on the parents.
b. Half of the amount that falls on the parents.
c. One-fourth of the amount that is directed to the background.
d. The same amount of light as that of the parents.

42. (423) When you see a photographer raise or lower the lights and have the subject tilt his chin up or down, which of the following distractions is the photographer trying to eliminate?

a. Glare in the subject's glasses.
b. Bright spots on the subject's uniform.
c. Visibility of the background light.
d. Softness of focus on the subject's eyes.

43. (424) Which of the following would be the least effective supplementary reflector?

a. A handkerchief.
b. Aluminum foil.
c. White paper.
d. A dark cloth.

44. (424) Which one of the following characteristics is generally associated with umbrella lighting?

a. Harsh.
b. Direct.
c. Diffused.
d. Supplemental.

45. (425) To use cleaning fluid to clean a lens, you put a drop or two of fluid on the

a. lens tissue.
b. camel's-hair brush.
b. shutter leaves.
d. lens barrel.

46. (426) What type of lighting should you strive for in copy work?

a. Contrasting.
b. Even.
c. Angled.
d. Parallel.

47. (426) What are the two methods of lighting control to use to subdue or eliminate surface reflections in copy work?

a. Bounce and specular.
b. Polarized and specular.
c. Specular and angled.
d. Bounce and polarized.

48. (427) A black-and-white line original generally has

a. low contrast.
b. two tones.
c. shaded colors.
d. blocked highlights.

49. (427) When you are trying to subdue a stain on a print you should use a filter that is

a. the same color and darker than the stain.
b. the same color and lighter than the stain.
c. opposite to and darker than the stain.
d. opposite to and lighter than the stain.

50. (428) Which of the following is not a characteristic of photomechanical film?

a. Thin base.
b. Low shrinkage.
c. Minimum stretch.
d. High speed.

51. (428) A color portrait would be reproduced best by using

a. medium contrast panchromatic film.
b. high contrast color blind film.
c. photomechanical panchromatic film.
d. process commercial ortho film.

52. (429) What would your bellows extension be if you were making a 50 percent reduction using a 4-inch lens?

a. 2 inches.
b. 4 inches.
c. 6 inches.
d. 8 inches.

53. (429) What would the bellows extension factor be if your bellows extension was 10 inches and the focal length of the lens was 5 inches?

a. 1.
b. 2.
c. 3.
d. 4.

54. (430) When you process by inspection you should watch for density buildup in the

a. highlights, contrasts, and lines.
b. shadows, lines, and clear areas.
c. contrasts, shadows, and clear areas.
d. shadows, lines, and highlights.

55. (430) To process reversal copy films you must have

a. yellow safelights.
b. two developers.
c. autopositive chemistry.
d. reversal reels.

56. (431) Which of the following copy negative defects can be corrected by spotting?

a. Blocked highlights.
b. Bleeding lines.
c. Pinholes.
d. Fogging.

57. (431) The main purpose of opaquing a copy negative is to

a. reduce negative densities.
b. reduce printing times.
c. eliminate dense pinholes.
d. eliminate objectionable areas.

58. (432) Operator maintenance in the copy room begins with

a. your supervisor.
b. good housekeeping.
c. 5-level photographers.
d. repair personnel.

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CDC 23132

APPRENTICE STILL PHOTOGRAPHIC SPECIALIST

(AFSC 23132)

Volume 4

Photographic Laboratory Applications

Extension Course Institute

Air Training Command

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THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

Preface

THIS FOURTH VOLUME of CDC 23132, *Apprentice Still Photographic Specialist*, brings you back into the laboratory. Here, we present to you proper darkroom procedures and techniques. Then we mention some of the ways to correct for those inevitable mistakes. However, our aim is for you to learn the proper methods so that you will not need to use corrective techniques.

In Chapter 1, we cover the basics of black-and-white chemistry. All of the camera techniques in the world are of no value if you mix your solutions improperly.

Chapter 2 deals with the procedures you must use once you have the solutions properly mixed and the material placed into it. We present film and developer combinations and what to do after you get the film wet.

Chapter 3 presents information on making black-and-white prints. Solutions, materials, accessories, etc., are all explained and discussed for you. Here we present the proper methods and then some of the corrective techniques. Pay attention to both but strive to use the proper methods.

In Chapter 4, we send you to finishing school. That is, we show you how to put the finishing touches on your prints.

Chapter 5 introduces you to the exciting world of color photography. Theory, film, processing, and finishing are all a part of this world. We keep to the basics in this chapter except for slide duplication.

The final chapter of this course is called Quality Control. If you take steps to control the quality of your work, you are well on your way to being that accomplished photographer we talked about in other volumes.

If you have questions on the accuracy or currency of the subject matter of the text, or recommendations for its improvement, send them to the 3430 Technical Training Group/TTMZS, Lowry AFB, CO 80230. Questions requiring an immediate resolution may be directed to the course authors at Autovon 926-4142 between 0800 and 1600 (MST) Monday through Friday. NOTE: Do not use the suggestion program to submit corrections for typographical or other errors.

If you have questions on course enrollment or administration, or any of ECI's instructional aids (Your Key to Career Development, Behavioral Objective Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If this agent can't answer your questions, send them to ECI, Gunter AFS AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 24 hours (8 points).

Material in this volume is technically accurate, adequate, and current as of January, 1979.

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CHAPTER 1

NOTE: In this volume, the subject matter is developed by a series of Learning Objectives. Each of these carries a 3-digit number and is in boldface type. Each sets a learning goal for you. The text that follows the objective gives you the information you need to reach that goal. The exercises following the information give you a check on your achievement. When you complete them, see if your answers match those in the back of this volume. If your response to an exercise is incorrect, review the objective and its text.

Black-and-White Chemistry

THE BASIC FUNCTION of the laboratory portion of the photographic process is to produce negatives and make prints. The conventional method of doing this is through the use of chemical solutions. The two primary solutions used to make black-and-white negatives and prints are the developers and the fixers. There are, however, other solutions in the black-and-white process that are used along with developer and fixer to produce a quality image. In this chapter you will learn the functions of black-and-white chemical solutions and specific applications. Also, you will learn how to properly prepare photographic chemistry and the operation and maintenance of chemical mixing equipment and mixing facilities.

1-1. Processing Solutions

There are five basic steps in processing black-and-white films and papers. These are development, rinsing, fixing, washing, and drying. Let's discuss the functions of the chemical steps used to produce the black-and-white photographic image.

600. State the function of the chemical solutions used to process black-and-white films and papers.

Developers. The function of a developer is to produce a silver image which constitutes a photographic negative or print. The process is known as chemical reduction, and it produces an image made up of black metallic silver. Developers do their work in a selective manner, reducing to black metallic silver, only those silver halides that have been exposed to light. Developers differ from one another on how fast they work and the contrast that they produce. Developers can generally be classified by the amount of contrast that they are capable of producing. There are low, medium, and high contrast developers, each having a particular application in photography. Your choice of which developer to use can be narrowed down to the type of film you need in taking a photograph. Photographic films are also classified by their contrast capability. There are low-, medium-, and high-contrast films. You would use a medium-contrast film to photgraph a medium-contrast subject and it also follows that a medium-contrast producing developer should be used to process your film, high-contrast film/high-contrast developer, etc.

Film manufacturers recommend the type of developer to be used with their films, and this information is contained in the film data sheet packed with the film. The developers that they recommend are the ones that give the best overall results.

Another factor that must be considered about developers is the negative grain size that they produce. There are fine-grain and moderate-grain developers. Your choice here depends upon the use of the negative. When you need to make big enlargements from small negatives such as 35mm, a fine-grain film developer such as Microdol-X or D-76 should be used. Large negatives such as 4 by 5 inches (10 by 13 cm) can be processed in a developer that produces medium grain because the degree of enlargement for making prints from large negatives is much less than for small negatives. So you see, the choice of developer depends upon many variables such as image contrast, type of film, and size of prints required.

Stop Bath. Between the development and the fixing steps, a stop bath also known as a short stop is used. The function of a stop bath is to stop the action of the developer. The most basic stop bath is simply a water rinse between the developer and fixing steps. This is not a stop bath in the true sense of the word because a water rinse cannot completely stop development. It only slows it down. A water rinse is usually sufficient when you are processing small batches of prints or film and working at relatively low processing temperatures. A water rinse is used more often when processing films than when processing prints.

A true stop bath contains an acid, usually acetic acid. The purpose of the acid is to neutralize the alkalinity of the developer. This stops development because most developers work only in an alkaline state. There are other stop-bath formulas that contain a hardener such as chrome-alum that hardens the emulsion that is swollen and soft after development. This type of stop bath is usually not needed unless you are working at temperatures above 75° F (24° C). A variation of the chrome-alum stop bath is one known as an indicator stop bath. Indicator stop baths have added to the solution a dye that becomes visible just before the stop bath is exhausted so that you can replace it with a fresh bath. A typical indicator stop bath changes from a light yellow color to deep purple when the solution becomes exhausted.

Fixing Bath. The fixing bath is the third step in processing black-and-white materials. The fixing bath makes the image permanent. It does this by dissolving the unexposed and undeveloped silver halides remaining in the film emulsion. It does this without attacking the metallic silver image. This is important because if these unexposed, undeveloped silver halides are not removed, they will eventually darken and stain, ruining the image. The most basic fixing bath (there are many) is made up of sodium thiosulfate dissolved in water. The common name given to this fixing bath is Hypo, a term many photographers use for all fixing baths. Other fixer formulas become more complicated with the addition of hardeners such as potassium alum, buffers such as boric acid to maintain proper solution acidity and prevent sludge, and sodium sulfite that acts as a preservative. The purpose of these additives is to extend the life of the fixing bath.

It really doesn't matter what type of fixing bath you use. What does matter is that you use the bath properly and do not allow it to become exhausted. When an exhausted fixing bath is used, no amount of washing can remove the complicated by-products of fixation from the emulsion. Because of this, many photo labs use a two-bath system. The first bath is a partially-used fixing solution, and the second bath is a fresh solution. When the first bath becomes exhausted, the second bath is moved into the first position and the exhausted bath is poured into a holding tank for silver recovery. The second tray is then filled with fresh fixer. This is an economical method that helps to insure that your prints have been adequately fixed.

Hypo-Clearing Bath. This solution is mildly alkaline in nature and it is used before the material is washed. Hypo-clearing baths are sometimes referred to as hypo eliminators. This is an erroneous term because they don't actually eliminate the fixer. Their action essentially is to raise the pH or alkalinity of the fixer within the emulsion. This higher alkalinity causes the fixer and by products to wash out faster. Hypo-clearing baths are useful because they save water by cutting down on the required wash time. They should be used wherever possible because of the savings in resources. Before treating films or paper in a hypo-clearing bath, rinse the material in water for about one minute.

Exercise (600):

1. Explain the function of each of the following:
   a. Developer.

   b. Stop bath.

   c. Fixing bath.

   d. Hypo-clearing bath.

1-2. Types of Photographic Chemicals

The preparation of photographic solutions is one of the most important tasks that you will perform. Accuracy in mixing is a must because without it, photographic quality will suffer. An improperly mixed solution is not readily recognizable and often the first indication that it was not properly mixed is when a batch of processed film or paper has been ruined. In this section we will discuss the principles of mixing photographic solutions using bulk chemicals which employ a photographic formula and the use of prepackaged chemicals. With the advent of prepackaged chemistry the necessity of mixing solutions from bulk is rapidly becoming a thing of the past.

601. Explain the advantages of using prepackaged chemicals.

Photographic chemicals that are used to prepare processing solutions can be obtained from manufacturers in two forms. These are bulk chemicals and prepackaged chemistry. Prepackaged chemistry is used more often, so we discuss this type first.

Prepackaged Chemicals. The majority of your chemical needs can be met through the use of prepackaged photographic chemistry.

These are convenience items because the manufacturer has saved you a lot of trouble by mixing in all the chemical ingredients required to make a solution and placing them into one or two packages. In effect, the manufacturer has prepackaged the complete formula so that you normally need only to add the package to the correct volume of water.

There are two basic categories of prepackaged chemistry: formula and proprietary. A prepackaged formulaic chemistry is one that can be easily duplicated from bulk chemistry, the formula used is common knowledge that can be extracted from such publications as the *Photo Lab Index* (Morgan and Morgan). Proprietary chemistry is one in which the formula of ingredients of the prepackaged chemistry are the exclusive property of the manufacturer and unknown to the general public. A formulaic chemistry is D-72 which can be purchased in the prepackaged form but also can be duplicated by using the published formula printed in the *Photo Lab Index*. Proprietary chemistry, however, can be purchased only in the prepackaged form. As you can see, there are really two reasons for prepackaged chemistry; convenience and protection of the formula rights for some chemical solutions. Kodak's Dektol for example, can be purchased only prepackaged and the formula is unpublished. Prepackaged chemicals are easy to store, handle, and mix and they provide consistent quality.

Prepackaged chemicals are available to cover all your photographic needs. You can order preparations for developers, stop baths, and fixing baths as well as toners, reducers, intensifiers, and the like. There are a number of different photo chemical manufacturers, and you will have a wide selection within the context of the Federal supply system. Always keep in mind that you should choose chemicals that are compatible with the films and papers that you are using.

The preparation of prepackaged chemicals requires mainly that you follow the directions carefully. Premixed chemicals may be in powder or liquid form. There may be several parts in the package that must be mixed in a certain manner. Typically, the contents of the package are to be mixed with a specific quantity of water. The water must be at the prescribed temperature. The majority of prepackaged chemicals are mixed in warm water, but read the instructions to make sure. (Remember that the temperature for mixing may not be the same as the processing temperature, so you may have to wait for the solution to cool to the correct temperature for use.) When there is more than one part, make sure that the parts are added in the correct order. Do not be in such a rush that you fail to follow directions.

Remember to follow the proper procedures for chemical safety. You should prepare the chemicals in a well-lighted and ventilated room. Do not taste or inhale any chemical. You should wear rubber gloves, apron, and mask for your personal protection. Remember, for safe mixing and quality results, follow directions.

Exercises (601):

1. What are the two types of packaged chemicals?

2. State four advantages offered by packaged chemicals.

3. What is the most important rule to keep in mind to insure consistent results when using packaged chemicals?

4. In what type of environment should package chemicals be prepared?

602. Explain the reasons for using bulk chemicals and specify nomenclature, equipment, and procedures related to bulk chemicals.

Bulk Chemicals. An alternative to packaged chemicals is preparing your solutions by using available formulas (found in the *Photo Lab Index*, etc.) and bulk (i.e., raw) chemicals. In this section, we shall briefly cover the use of bulk chemicals.

Mixing solutions by referring to published formulas (in the *Photo Lab Index*, etc.) and using bulk chemicals can be advantageous. You can prepare solutions you rarely use (e.g., toners) or those which are not available in premixed form. You may have to use bulk chemicals to meet special mission requirements.

Chemical Grades. It is important when using bulk chemicals that you are aware of the standards of chemical quality. The United States of America National Standards Institute (USANSI) publishes a series of standards covering all of the chemicals used in photographic processes. These USANSI standards contain specifications that establish the degree of purity and state limiting concentrations for potentially harmful impurities that may be present. You can prevent faulty processing caused by the use of chemicals of inferior quality by using only a grade of chemical that meets or exceeds these USANSI standards.

Chemicals such as sodium sulfite, sodium carbonate, hydroquinone, Metol, etc., that are used in large quantities by the photographic industry, are designated as "Photo Grade" by most suppliers of chemicals. This designation means that the chemical so rated meets the USANSI specifications for photographic grade chemicals. "Photo Grade" or a similar designation is not, however, one of the standard designations of chemical purity commonly used by chemical manufacturers. The quality designations most often used are given below with a brief definition of each.

- Primary Standard: A specially manufactured and tested analytical reagent of exceptional purity. Used exclusively for standardizing laboratory volumetric solutions and preparing reference standards.
- ACS or Reagent Grade: A chemical that fully meets the requirement of the American Chemical

Society for Reagent Grade chemicals. Used in analytical laboratories for testing and evaluating other chemical preparations.

- C.P.: Chemically pure grade, generally exceeding U.S.P. or N.F. requirements, but slightly lower quality than Reagent Grade.
- U.S.P.: A grade meeting the requirements of the United States Pharmacopoeia (i.e., medicine).
- N.F.: A grade meeting the requirements of the most recent, or designated, issue of the National Formulary. (U.S.P. and N.F. Grade chemicals are primarily for drug use.)
- Purified: A grade of higher quality than Technical, often used where there are no official standards.
- Technical: A grade suitable for general industrial use.

Generally speaking, USANSI photographic grade chemicals are within the quality range of the U.S.P., N.F., and Purified grades. C.P. Grade chemicals are always suitable for photographic use but are of a higher quality (and cost) than is generally required. Reagent Grade and Primary Standard chemicals are very costly and are much purer than is required for photographic purposes. Some Technical Grade chemicals are satisfactory for photographic use. Their low price and availability make them desirable but, for precise photo applications, they should be thoroughly evaluated before use.

Prior to using chemicals of unknown grade, you should obtain the USANSI specifications for the particular chemicals in question and perform the laboratory tests as given in these specifications. Chemicals failing to meet the given purity limits should not be used in preparing photographic solutions.

Bulk Chemical Storage and Procedures. Bulk chemicals should be kept in appropriate dark (amber, etc.) stoppered bottle or jars for proper keeping in a cool, dry place away from sensitized materials. All containers should be properly labeled, as many chemicals are poisonous. Maximum safety can be insured by keeping all the toxic chemicals in a locked cabinet to which only authorized personnel have access.

To take advantage of bulk chemicals, you need a properly stocked chemical mix section. An accurate balance, graduates, thermometer, and stirring rods are a few of the basic items required. Personnel who mix chemicals should be thoroughly trained in proper procedures, including reading a formula, using mixing equipment, and observing proper chemical safety practices.

You are perhaps tired of being continually reminded about chemical safety, but it must be stressed over and over again with the hope that you will make it a habit in your work. Any accident brings hardship to everyone in the section. To this end, here is another review of basic safety procedures that are particularly applicable when you are using bulk chemicals.

- Never smell a chemical directly from the bottle. Instead, hold the bottle at a distance from your nose, and sniff its contents cautiously rather than inhale directly.
- Never taste a chemical.
- Handle all chemicals cautiously: many will produce burns or skin irritation.
- When mixing a strong acid with water, add the acid slowly to the water while stirring continuously; otherwise, the solution may boil violently and splatter on your hands and face, causing serious burns. Remember: *Never pour water into acid.*
- Be sure that the chemical mixing room or area in which you are going to mix chemicals is well ventilated. The fumes or dust from some chemicals can be very irritating to your nose and eyes, as well as harmful to photographic sensitized materials.
- In all cases, be sure to see a doctor as soon as possible in the case of an accident.

Exercises (602):

1. What are the advantages of using bulk chemicals?

2. What grade of chemical is normally used in photographic work?

3. Under what circumstances can you use Technical Grade chemicals for photographic work?

4. How should bulk chemicals be stored?

5. What type of facilities do you need in order to use bulk chemicals?

6. How should acid and water be mixed? Why?

1-3. Preparation of Chemical Solutions

In the Air Force, we use two methods of mixing chemicals (1) hand mixing and (2) machine mixing.

Hand mixing can be used when small quantities of solutions are needed or when machines are not available. Machine mixing is necessary to handle the large production requirements of most labs. In this section we point out the operation of the A-1 mixer, which is typical of the mixing units you will be using.

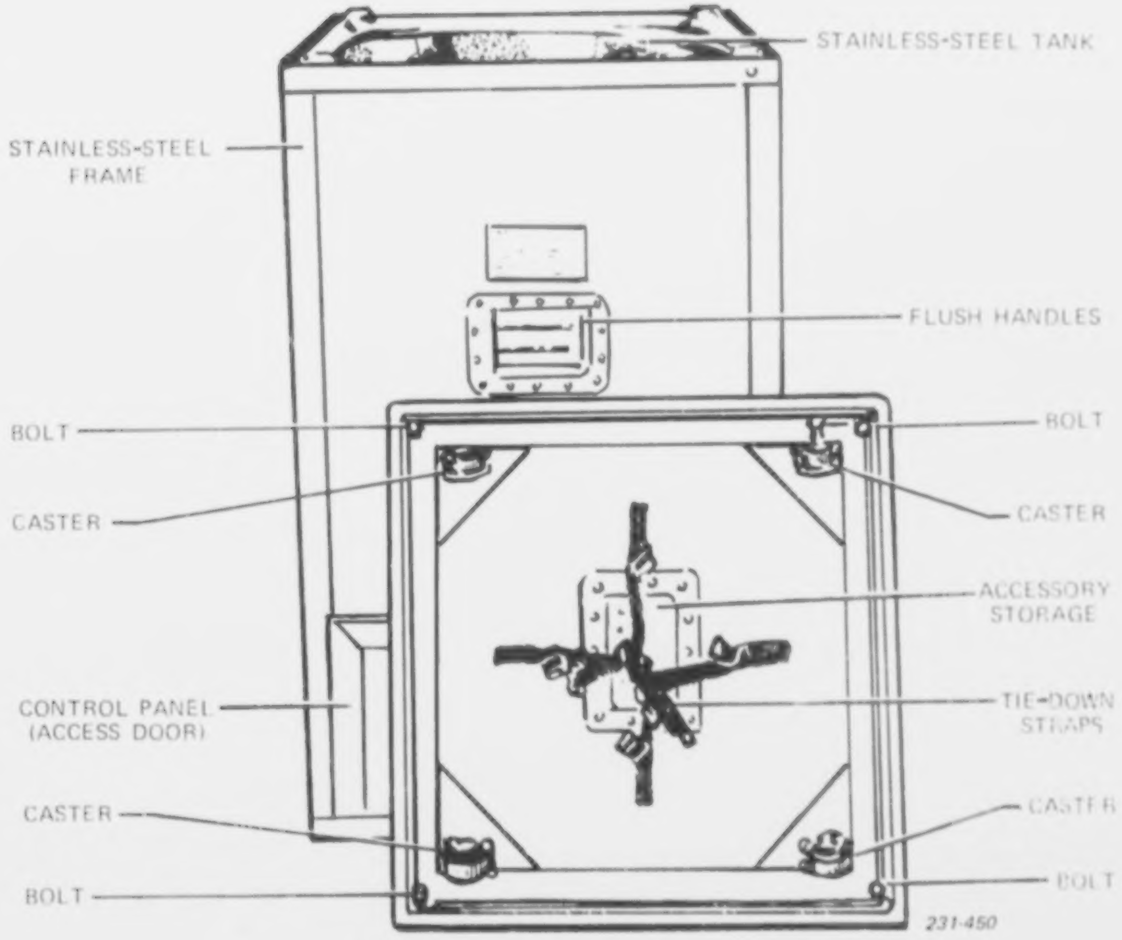

Figure 1-1. A-1 mixer distributor.

603. Indicate nomenclature specifications and procedures related to the operation of the A-1 mixer.

A-1 Mixer Distributor. The A-1 mixer-distributor, shown in figure 1-1, is designed for mixing chemical solutions and distributing the batch to the point of use. While the A-1 mixer can mix 50 gallons of chemicals at one time, it has the advantage of being mounted on casters, allowing you to mix the chemicals in one location and then wheel the mixture to another location for distribution.

The mixer operates by using a series of valves and a pump. Two valves, similar in construction, are located on the control panel, shown in figure 1-2. Opened and closed by rotating the handles, they interconnect the IN hose coupling (valve B) and the OUT hose coupling (valve A) when in the closed position. If the valves are in the closed position, the solution in the mixing tank circulates through the pump and back into the mixing tank.

Prior to operating the mixer, you need to connect the hose with the gooseneck to the coupling marked "OUT," located on the extreme left side of the control panel. Next, connect the second hose to the coupling marked "IN," on the extreme right side of the control panel. The next step is to suspend the calibration dipstick from the inside lip of the tank. The dipstick is calibrated in gallons for solution measurement.

Pump purging. Before the pump can operate efficiently, air must be purged from the system as follows:

(1) Open valves A and B 1/4 of a turn.

(2) Pour 3 gallons of water into the tank.

(3) Position the switch at low speed and allow the mixer-distributor to operate for a long enough period to circulate the water through the pump.

Tank filling. To fill the mixer-distributor tank; proceed as follows:

(1) Purge air from the tank.

(2) Submerge the inlet accessory hose into the solution supply tank.

(3) Open valve A and close valve B.

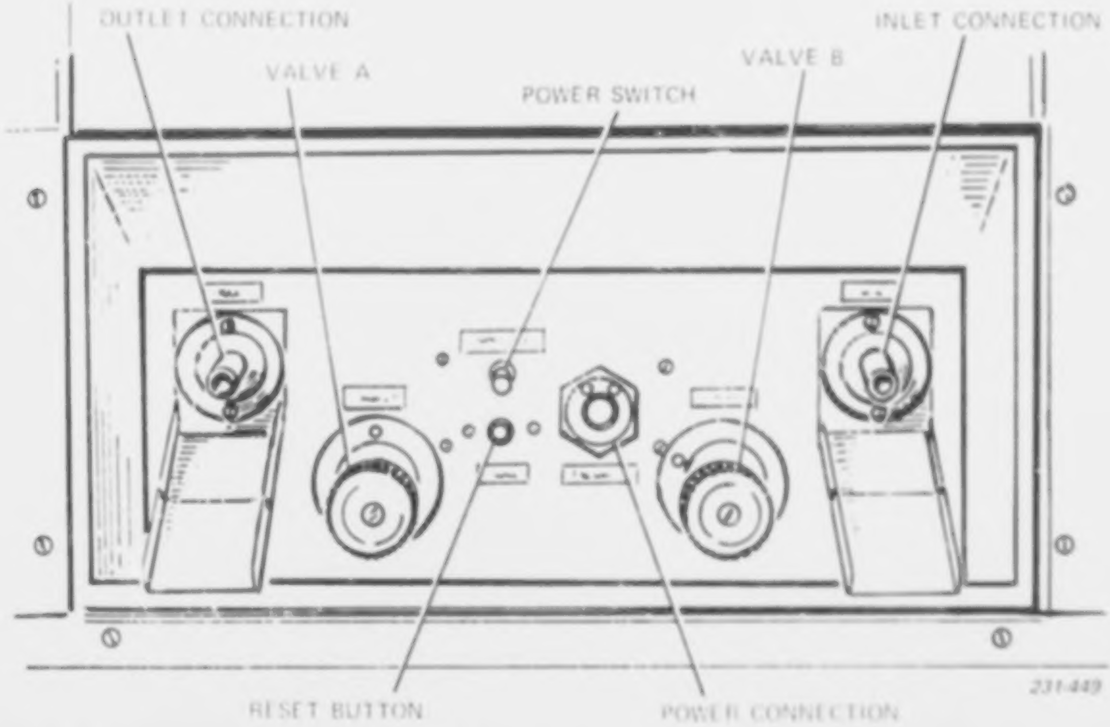

Figure 1-2. A-1 mixer distributor controls.

(4) Turn the power switch to high.

Mixing solution. To mix your chemicals, fill the mixer with the required amount of water at the appropriate temperature and then open valves A and B. Turn the power switch to high. The water will be drawn through an outlet in the bottom of the mixing tank, circulated through the pump, and then pumped back into the mixing tank.

Once you are sure that the water is circulating (this is indicated by motion of the water), add the chemicals in the order specified in the formula or mixing instructions. Be sure to break up any large lumps of chemicals into small pieces in order to insure mixing. When pouring the chemicals, hold the chemical container close to the surface of the water. This technique cuts down on dust and prevents splashing.

During mixing, you may find it necessary to dislodge undissolved solids on the bottom of the tank. To do this, stir the solution with a long stirring rod or chemical mixing paddle. The occasinal stirring insures that all chemicals are being dissolved into the solution.

After all your chemicals have been dissolved, add cold water to bring the solution to its final volume.

Distributing mixed solution. Distribute the mixed solution as follows:

(1) Place the gooseneck on the outlet accessory hose over the edge of the working or storage tank to be filled.

(2) Close valve A.

(3) Open valve B.

(4) Position the power switch at high speed and allow the mixer-distributor to operate until the working or storage tank is filled.

Recirculating mixed solution. To recirculate the solution through the mixer-distributor tank and the working or storage tank, proceed as follows:

(1) Submerge the inlet accessory hose into the working or storage tank containing the solution to be recirculated.

(2) Place the gooseneck on the outlet accessory hose over the edge of the same tank in which the inlet hose is submerged.

(3) Turn both valve handles to a position halfway between full clockwise and full counterclockwise.

(4) Turn the switch to high speed and allow the mixer-distributor to operate until the old solution is mixed with the new.

Transferring solution. To transfer solution from one working or storage tank to another, proceed as follows:

(1) Purge air from the pump.

(2) Submerge the inlet accessory hose into the working or storage tank containing the solution to be transferred.

(3) Place the gooseneck on the outlet accessory hose over the edge of the tank to which the solution is to be transferred.

(4) Close both valves.

(5) Position the switch at high speed and allow the mixer-distributor to operate until the solution is transferred.

NOTE: Be sure to check the appropriate operating instructions for the mixer that you are using. This precautionary action will insure safe quality operation.

Exercises (603):

Complete the following statements on the operation of the A-1 mixer.

1. You can mix up to ____________ gallons in the A-1 mixer.
2. The IN hose coupling is controlled by ____________.
3. Prior to operation, the pump should be purged of ____________.
4. When the A-1 mixer is mixing chemicals, its valves are ____________.
5. Both valves are in an intermediate position when ____________ mixed solution.

604. Briefly state why it is important to follow manufacturers' directions when preparing photographic chemicals.

Before you mix any photographic chemicals you should carefully read the manufacturer's directions. Much effort went into the production of the chemical product but it is only effective if it is used in the way that it was designed. The directions of even the most familiar product should be reviewed, as there are continuous attempts to upgrade photographic materials. For example, new film developer combinations may call for changes in dilution, time, or temperature of solutions to get the required results. Following the directions is very important in the preparation of chemicals for both quality and safety reasons.

When working with photographic chemicals, you will be using either packaged or bulk chemicals. Packaged chemicals are your ready-mixed types. The directions normally require the thorough mixing of the package contents with water. The key to following packaged chemical directions is insuring that the right quantity of water at the required temperature is used. In addition, many packaged chemicals have more than one part. Each part must be mixed in proper sequence. Because packaged chemicals will probably meet all of your routine needs for developers, stop baths, fixing baths, toners, etc., it is important that you get into the habit of carefully reading the directions for preparing them.

Using bulk chemicals requires following a formula that tells you the various chemical ingredients that must be dissolved into water. Unlike most packaged chemicals, the use of bulk chemicals calls for very precise measurement of each ingredient. This requires both caution and a knowledge of measuring in order to carry out the directions.

It is a good idea to keep a file of the various direction sheets. Such a file provides a quick reference for selecting the appropriate chemical for the job and is a good backup to have in case of loss of the original data sheet. An alternative source of information is the *Photo Lab Index* published by Morgan and Morgan, Inc. This publication contains a wealth of manufacturers' information.

Exercises (604):

1. Give two good reasons why it is important to follow manufacturers' directions when you are preparing photographic chemicals.

2. For packaged chemicals, you must add the right quantity of ____________ at the required ____________.

3. For bulk chemicals, you must follow a formula, measuring each ____________ precisely and usually dissolving them in a specified amount of ____________.

4. A file of various direction sheets serves as both a ____________ and a ____________.

605. Apply principles of mathematics to solve mixing problems.

The key to employing a photographic chemical formula is the ability to follow formula directions. This requires knowledge of chemical mathematics and measuring procedures.

The following is a typical Kodak Formula, presented to show you the basic format:

Kodak Developer D-13 (Tropical Process Developer for Films)

Water (125° F or 52° C)	24 ounces	750.0 ml
Kodak Elon	75 grains	5.0 grams
Kodak Sodium Sulfite, desiccated	1¾ ounces	52.5 grams
Kodak Hydroquinone	145 grains	10.0 grams
Kodak Sodium Carbonate (monohydrated)	2 ounces	60.0 grams
Potassium Iodide	30 grains	2.0 grams
*Kodak Sodium Sulfate, desiccated	1½ ounces	45.0 grams
Add cold water to make	32 ounces	1.0 liter

*If it is preferred to use sodium sulfate crystals instead of the desiccated sulfate, then use 3½ ounces per 32 ounces (105 grams per liter).

Dissolve chemicals in the order given.

Use without dilution. Develop 6 to 7 minutes at 85° F (29° C) or for proportionately longer times at lower temperatures. Rinse thoroughly for 30 seconds and immerse for 3 minutes in 5% formalin solution 37% formaldehyde, diluted: 1 part formaldehyde to 19 parts water). Then wash for 1 minute, fix 5 to 10 minutes in an acid hardening fixing bath (Kodak Fixing Bath F-5), and wash for 15 to 20 minutes.

Note the importance of having a warm water temperature for mixing. Warm water helps in dissolving the different chemicals. Following the mixing of the chemicals, cool the solution down to the processing temperature.

Chemical Mathematics. Solutions are prepared in terms of strength. The strength of a photographic solution is identified in two different ways: percentage or parts. You need to know how to mix either type.

Percentage solutions. There are several common methods of making up a percentage solution. The one used in photography is to measure out the appropriate chemical in a parts-per-hundred ratio. For example, to make a 10-percent solution of sodium sulfite, you dissolve 10 grams of sodium sulfite in 100 cc of water.

Parts solutions. To prepare a part solution, you mix 1 unit of chemical with a specified number of units of water. These units can be of any weight from grams to pounds, provided that you measure all quantities in the same unit of weight or volume. For example, to prepare a 1:2 solution of D-76 developer, you mix 1 unit of stock D-76 solution with 2 units of water. The results are correct as long as identical units of measurement are used for each part of the formula (e.g., 16 ounces of stock solution with 32 ounces of water).

NOTE: The term "stock solution" identifies a concentrated chemical solution. A "working solution" is the solution used for processing. The working solution may be the same as the stock solution, but most often it is a diluted stock solution, like in the D-76 example.

Conversions. Whenever you are given a dilution ratio for making a working solution and you need to make a certain amount of working solution, determine the percentage of stock solution required. Suppose that your supervisor asks you to prepare two gallons acetic of ~~acetic~~ acid diluted from glacial acetic acid at a 3:8 ratio of dilution. The problem here is to determine how many ounces of glacial acetic acid must be used. You do this by converting the ratio into percentages. The first number in the ratio represents the parts of stock solution required. Convert this into a percentage using the following formula:

$$\text{Percentage} = \frac{\text{First number of ratio}}{\text{Sum of ratio}}$$

$$\% = \frac{3}{3+8} = \frac{3}{11} = 27.3\%$$

This is the percentage of the two gallons of solution that must be glacial acetic acid. To determine how

TABLE 1-1
CONVERSION FACTORS

TO CONVERT FROM	TO OUNCE	POUNDS	GRAINS	GRAMS
OUNCE	1.0	.0625	437.5	28.3495
POUNDS	16.0	1.0	7000.0	453.593
GRAINS	.002286	.0001429	1.0	.064799
GRAMS	0.03274	.002205	15.4323	1.0

MULTIPLY BY FACTOR GIVEN ABOVE

OUNCES PER 32 FLUID OZ MULTIPLIED BY 29.96 = GRAMS PER LITER
POUNDS PER 32 FLUID OZ MULTIPLIED BY 479.3 = GRAMS PER LITER
GRAINS PER 32 FLUID OZ MULTIPLIED BY 0.06847 = GRAMS PER LITER
GRAMS PER LITER MULTIPLIED BY 0.03338 = OUNCES PER 32 FLUID OZ
GRAMS PER LITER MULTIPLIED BY 0.002086 = POUNDS PER 32 FLUID OZ
GRAMS PER LITER MULTIPLIED BY 14.60 = GRAINS PER 32 FLUID OZ

231-544

many ounces 27.3 percent is, you convert 2 gallons to ounces which is 256. Then you determine that 27.3 percent of 256 equals 69.9 ounces. The solution must glacial contain 69.9 ounces of ~~glacial~~ acetic acid. Now you need to know how much of the solution must be water. Simply subtract 69.9 from 256 which is 186.1 ounces. You would add 69.9 ounces of glacial acetic acid to 186.1 ounces of water. CAUTION: *Never* add the water to the acid. This can cause a violent reaction. *Always* add acid to water very slowly.

Often the chemicals that you receive from your supply section are indicated by one type of measurement. To follow the directions of a particular formula, you may have to convert to another system. Table 1-1 shows the factors that you can use to make the conversions. For example, let's say that you receive a supply of sodium sulfite with the weight indicated as 5 pounds. However, your formula for a fixing bath calls for the addition of 2400 grams of sodium sulfite. You will want to know if the 5 pounds of sodium sulfite is enough to meet your requirements. Using table 1-1, you would multiply the number of grams in a pound, 453.593, by 5. Having done this, you can see that 5 pounds is equal to 2,267.965 grams. Therefore, you know that the 5 pounds of sodium sulfite is not enough; you must obtain an additional 133.035 grams.

Temperature conversions are another important consideration. If you need to convert Fahrenheit into Centrigrade, subtract 32 from the degrees Fahrenheit, multiply the difference by 5, and divide the product by 9. For example:

100° F = x° C
(100 − 32) x 5 ÷ 9 = x
68 x 5 ÷ 9 = 37.77
x = 37.8° C

On the other hand, if you desire to convert Celsius into Fahrenheit, multiply the Celsius degrees by 9, divide by 5, and add 32 to the result. Here is an example of what we mean:

$100^\circ C = x^\circ F$

$100 \times 9 \div 5 + 32 = x$

$900 \div 5 + 32 = x$

$180^\circ + 32 = 212$

$x = 212^\circ F$

Exercises (605):

1. How should you mix 100 cc of a 25-percent solution of hydroquinone?

2. How should you make a 1:3 working solution of D–72?

3. 68° F. is equal to how many degrees Celsius?

4. 50° C. is equal to how many degrees Fahrenheit?

5. A 1:4 solution of D–19 is equal to what percentage of D–19?

606. State principles, procedures, and facts related to chemical measuring.

Mixing Accuracy. Photographic quality control suffers if the chemicals are mixed in improper amounts. You must be certain that the amount of chemical you put into a solution is the amount specified in the formula. Therefore, you mst use accurate measuring devices such as chemical weighing balances and graduates.

Chemical weighing balances. There are two general types of chemical weighing balances in use throughout the Air Force: the metric and the avoirdupois. The metric balance is used to measure milligrams, grams, or kilograms, whereas the avoirdupois balance is used to measure grains, ounces, and pounds. When you are weighing chemicals for mixing, the type of balance to use depends on the unit of weight measurement called for in the formula. If, for example, the formula asks for a specific number of grams, you should use a metric balance. If, on the other hand, the formula calls for a specific number of grains, you should use the avoirdupois balance.

As important as choosing the correct type of balance for your chemical weighing is using a balance of the correct capacity for the job. For example, one typical developer formula may call for 5.0 grams of potassium bromide per liter of solution. If you use a large-capacity balance capable of measuring hundreds of grams with an accuracy of ± 1.0 gram, the amount of chemical weighed out for the solution could be as little as 4.0 grams or as much as 6.0 grams. Such variation from the exact, desired amount of chemical can radically alter the characteristics of the developer and would, at the very least, seriously affect the batch-to-batch uniformity. When choosing a balance for chemical measurement, always apply the rule that the smaller the quantity to be weighed, the greater must be the accuracy of the balance. Small quantities of chemicals—500 grams or less (or 1 pound or less)—are best weighed on a balance that is accurate to 0.1 gram (or 1 grain). Weigh large quantities on larger-capacity balances having a proportionate degree of accuracy.

Figure 1-3 illustrates a typical chemical weighing balance. This is a balance used for weighing quantities of chemicals from 0.1 gram to 210 grams (1.54 grains to 0.46 pound). This balance has a maximum capacity up to 2 kilograms when supplementary weights are used. There are larger balances that weigh chemicals in much larger quantities, but we shall use the balance in figure 1-3 to illustrate the principles that apply to nearly any type of balance.

The balance shown in figure 1-3 is essentially a lever with equal arms on either side of the beam bearing (or fulcrum). Weight is added to the right arm of the beam in known quantities. The chemical to be weighed is then added to the left arm until the weights balance.

Some balances, such as the ones shown in figure 1-3, have sliding weights mounted upon a calibrated scale on the beam. Moving the siding weights from left to right increases the weight on the right end of the beam. Study figure 1-3 and notice that the upper sliding weight can be positioned from 0.0 gram to 10 grams in increments of 0.1 gram. The lower sliding weight can be positioned from 0.0 gram to 200 grams in increments of 10 grams. When using a combination of the two sliding weights, you have a range of 0.0 gram to 210 grams in increments of 0.1 gram.

Many balances do not have calibrated sliding weights but are instead supplied with individual weights of varying sizes. These range from 1 gram to 10 pounds, etc., depending on the particular balance.

The heart of the beam balance is the bearing surface that supports the beam. Since friction at this point must be held to an absolute minimum in order to give you accurate measurements, this bearing arrangement is critical and delicate and will not stand any abuse. You must give the chemical balance the same care as that given to any extremely delicate precision instrument.

Pans are used on the balance arms to hold the material that is being weighed. The pans are also used to hold the weights when separate weights are used for making the measurement.

A sheet or disc of paper should be placed in each pan before placing individual weights in them. This helps prevent the pans from corroding. Change the paper for each successive chemical you are weighing. Handle the individual weights with tweezers or forceps to prevent them from becoming corroded.

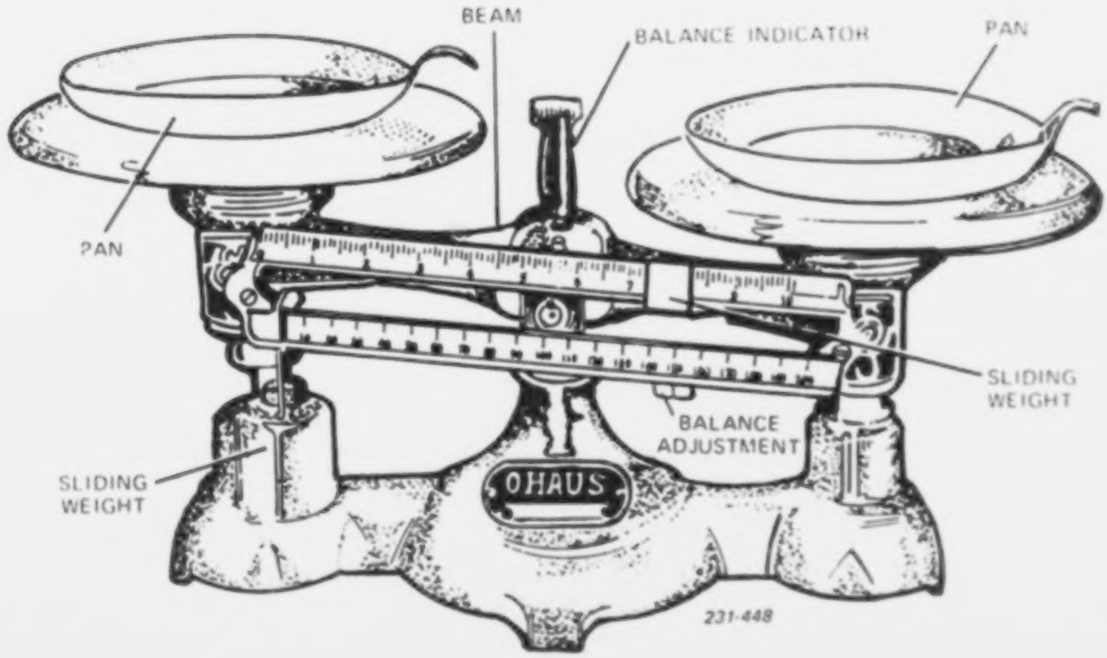

Figure 1-3. Chemical weighing balance.

A balance indicator on the beam balance shows when the material that is being weighed and the calibrated, counter-balancing weights aree equal. In the balance shown in figure 1-3 the indicator consists of a scale and pointer. You may find in other balances that the indicator is composed of two extensions over the center of the beam, which are part of the pan supports. A state of equilibrium is indicated on this type of balance when these two extensions are aligned.

The beam balance is equipped with a balance adjustment or trimming device. This adjustment, consisting of movable weights, can be positioned and locked to compensate for minor inequalities in the weights of the two ends of the beam that could, if not corrected, give you erroneous readings.

Photographic graduates. Besides using balances for measuring dry photographic chemicals, you will also use photographic graduates for measuring liquids. For instance, you would use the graduate for measuring the amount of sulfuric acid to put into a bleach solution.

Graduates are made in varying sizes, calibration, and construction material. Figure 1-4 illustrates two common types of glass graduates. Although most of the graduates you will use are calibrated in the U.S. liquid measurement system (drams, ounces, quarts, and gallons), it is not uncommon to find a graduate calibated in the metric liquid measurement system (liters).

Glass is most commonly used for making graduates because it is inert to most chemicals, transparent, and reasonably durable. Graduates are also made from other materials, such as plastics. When using graduates of plastic, be sure that you do not try to measure strong acids such as sulfuric acid, which could cause severe damage. You should also make sure that the material of the graduates you use does not react with any of your photographic chemicals.

To use the graduate, slowly pour into it the liquid to be measured. Stop pouring when the surface of the liquid reaches the calibration mark indicating the desired amount. Major divisions are indicated by numerals on the glass. Subdivisions are indicated by calibration lines only. You must compute the value of the individual subdivisions. For example, the marked lines may read in series of 10. If there is only one calibration line between each graduation of 10, then the calibration line would be for a value of 5.

Exercises (606):

1. the beam balances you are likely to use will probably be calibrated for what two weighing systems?

2. In terms of accuracy, what is the rule for choosing a balance?

3. Complete the following statements on the operation of a beam balance.

a. A beam balance uses either ________ or ________ weights.

b. ________ should be placed in each pan to prevent contamination.

c. Inequalities between the two ends of a beam is corrected by using the ________ device.

d. Chemicals to be weighed are placed in the ________ pan.

e. When individual weights are used, they are placed in the ________ pan.

f. Place a ________ in each pan to prevent corrosion to the pans.

g. Handle individual weights with ________ to prevent corrosion to them.

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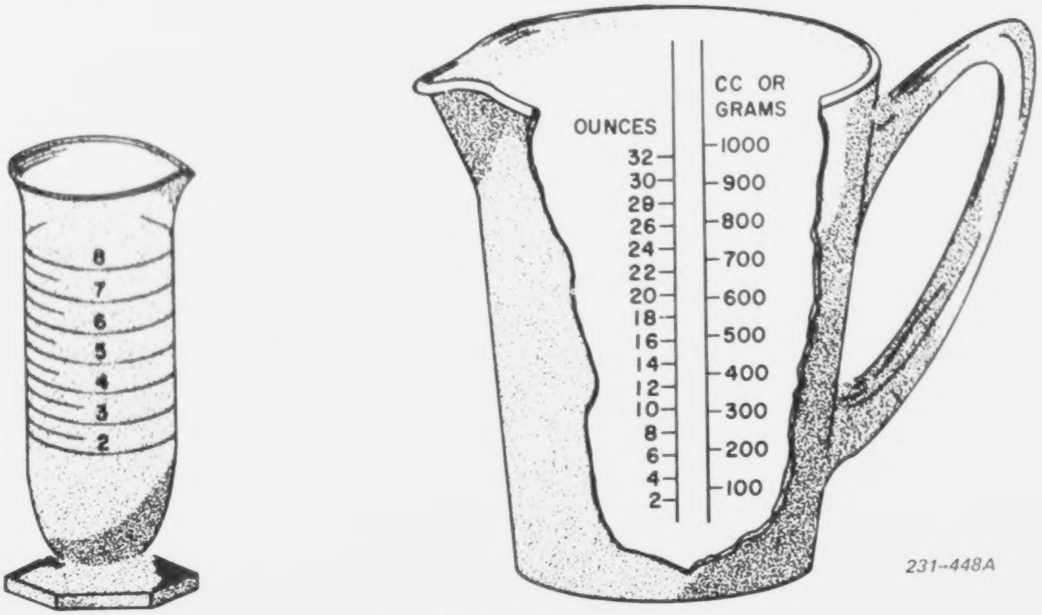

Figure 1-4. Photographic graduates.

4. What should be your main concern when you are considering the use of graduates made of different materials?

5. If there are four calibration marks between the 0 and 10 marks on a graduate, each calibration mark would stand for how much of an increase?

1-4. Environmental Protection

Environmental pollution is the presence of physical, chemical, and biological elements that adversely affect all living things. Pollution affects human health, alters ecological balances, affects animal and plant life, and causes deterioration of man-made objects. It includes noise, improper solid waste management, and other things conventionally thought of as pollutants.

Pollution is an economic, technical, and social problem. It is a problem because the earth and its inhabitants have only a limited supply of air and water. When these are gone, or contaminated to the point where they can no longer support life, all living things on earth, as we know them, will become extinct. Only recently have we become aware of the consequences of poisoning these two life-sustaining substances. Because of this awareness, much has been done to lay the groundwork for legislation to control water and air pollution.

The Refuse Act of 1899 requires that a permit be obtained before virtually any substance other than sewage is discharged into most streams, rivers, lakes, or other bodies of water. Failure to do so constitutes a criminal offense. Air Force personnel responsible for violating this act can be criminally prosecuted.

The Clean Air Act requires Federal installations to comply with Federal, state, interstate, and local requirements for the control and abatement of air pollution. This is more than just meeting air quality standards. For example, it means that it is necessary to apply for state permits where activities such as fire-fighting training requires state approval.

In this chapter, we discuss the environmental protection program of the Air Force with particular emphasis on photographic facilities. In light of this goal, we also discuss reclaiming silver from fixing baths.

607. From a list of possible environmental practices, identify those which are consistent with Air Force policy.

As explained in AFR 19 1, *Pollution Abatement and Environmental Quality*, environmental pollution is the presence of physical, chemical, and biological elements or agents that adversely affect human health or welfare, unfavorably alter ecological balances of importance to human life, adversely affect species of animal or plant life, cause damage to and deterioration of manmade materials or property, or degrade the utility of the environment for aesthetic and recreation purposes. Control of environmental pollution requires consideration of air, water, and land, and must extend to noise, improper solid waste management, and electromagnetic energy, as well as things conventionally thought of as pollutants.

The Federal Water Pollution Control Act, the Clean Air Act, and other recent Federal legislation require that Federal installations comply with Federal, state, and local legislation covering pollution. The Air Force, therefore, is actively involved in pollution control.

Air Force environmental policy encompasses the following principles:

a. Eliminate or control environmental pollutants generated by or resulting from Air Force operations or from contractor operations on real property owned, leased, or controlled by the Air Force consistent with the overall mission of the Air Force.

b. Lead in preventing, controlling, and abating environmental pollution by accelerating corrective measures at Air Force installations, and by initiating and supporting local area programs of local communities in developing area-pollution abatement programs.

c. Provide preventive pollution control by: (1) reducing or eliminating waste at the point of generation, (2) considering potential environmental pollution control problems when selecting chemical compounds and material to be used in Air Force operations, and (3) including pollution abatement as an element in specifications.

d. Dispose of discharge pollutants in a manner that will not, directly or indirectly, expose people to concentrations of any substance hazardous to health.

e. Insure that contracts for disposal of waste contain provisions that require the disposal method to be in accordance with applicable local, state, and/or Federal criteria and standards.

f. Install facilities or establish procedures to prevent heated water from increasing stream temperatures above acceptable limits.

g. Install treatment facilities where local facilities are not adequate.

h. Insure that all materials (including solid fuels, ashes, petroleum products, and other chemical and biological agents) are used, stored, and handled to avoid or minimize the possibilities of water and air pollution.

The Role of the Base Photo Lab. The base photo laboratory has an important role in carrying out the Air Force's environmental protection policies. The discharge of photographic solutions and waste into the sewage system poses a problem. A laboratory can promote safe disposal by making sure that the photographic solutions and waste are well mixed with water. If large amounts must be discharged, as when processing machines are drained, it would be best to collect the solutions in stand tanks and then control the outflow.

The photographic laboratory makes a vital contribution through the silver recovery program. The regeneration of silver-laden fixing baths and the recovery of silver from black-and-white films saves a vital national resource and reduces the amount of silver-laden waste that is discharged.

Exercise (607):

1. Which of the following practices are consistent with Air Force policy?
   a. Establishment of treatment facilities.
   b. Pollution disposal methods may violate local laws.
   c. Reduction of waste at the point of generation.
   d. Expose local residents to mercury poisoning.
   e. The discharge of large amounts of silver from base photographic operations.

608. Cite the effects, advantages, and disadvantages of equipment used in silver recovery from fixing solutions.

The annual production of silver in the United States accounts for only 25 percent of the Nation's industrial requirements. The balance must be obtained through purchase from foreign countries. This has an adverse effect on the Balance of Payments Program. The photographic industry uses approximately 43,000,000 troy ounces (12 troy ounces to a pound) of silver per year. The Air Force is a major consumer of photographic products. Therefore, recovery of silver from expended photographic material is vital in the interest of national economy, conservation of a critical material, environmental protection, and alleviation of the gold flow problem.

Silver is available for recovery from two main sources in the photographic field. One source is various exhausted processing solutions. The other is expended films, papers, and some printed plates.

Fixing baths used in black-and-white and color processing are rich sources of silver. The purpose of the fixing bath is to convert unexposed, undeveloped silver halides to water-soluble compounds tht can be removed from the emulsion. When black-and-white films are processed, up to 80 percent of the silver in the emulsion dissolves out and remains in solution in the fixing bath. The remainder of the silver forms the image. In color processing, *all* of the metallic silver in the film is converted to a silver salt in the bleach and is removed in the subsequent fixing bath.

Primary Fixers. The primary fixers used in Air Force photographic processing are ammonium thiosulfate and sodium thiosulfate, described thus:

a. Ammonium thiosulfate fixers are exhausted primarily by dilution. Dilution is caused by chemicals carried into the bath by the film and, in turn, fixer ingredients are carried out. The fixing rate of ammonium thiosulfate is affected very little by the silver concentration, so continuous recovery of silver *does not* extend its life. The justification for recovery is the silver itself. Also, with continuous silver recovery, all films enter the wash containing very little residual silver. Since the washing rate is extremely sensitive to the presence of silver, films with low residual silver wash more quickly and have superior archival properties.

b. Films fixed with sodium thiosulfate have wash properties similar to those fixed with ammonium thiosulfate; however, sodium thiosulfate is affected more by silver buildup and is more sensitive to its removal. Continuous silver recovery keeps the fixing time short and, more importantly, increases the fixer life by approximately 50 percent.

Methods of Silver Recovery from Fixer Solutions. There are three primary methods for recovering silver from used fixer solutions. These are electrolytic, metallic replacement, and chemical precipitation.

Electrolytic. In the electrolytic method of recovery, silver is removed from fixing baths by passing a controlled, direct electrical current between two electrodes (a cathode and an anode) that are hung in the solutions. Silver is deposited on the cathode in the form of a nearly pure silver plate. The cathodes are removed periodically, and the silver is stripped off. To maintain the highest efficiency and recover rates, silver content of the solution and amperage of the electrical current are constantly monitored electronically. This method is the only one that permits reuse of fixer after the silver is removed.

Medium and high-volume processing facilities that generate more than 30 gallons of exhausted ~~hypo~~ fixer solution per 8-hour day (except mobile laboratory facilities) should use an electrolytic recovery unit, such as the one shown in figure 1-5. Activities such as reconnaissance technical squadrons, radiographic laboratories, and base photographic laboratories profit by using this system.

Metallic replacement. Metallic replacement occurs when a metal, such as iron, comes in contact with a solution containing dissolved ions of a less active metal, such as silver. In this silver recovery system, the dissolved silver ions react with a solid metal, iron. The iron, being the more active metal, goes into solution as an ion, and an ion of the less active silver becomes solid metal.

Although silver ions can ~~display~~ displace ions of many of the common metals from their solid state, zinc and iron are the metals most commonly used to recover

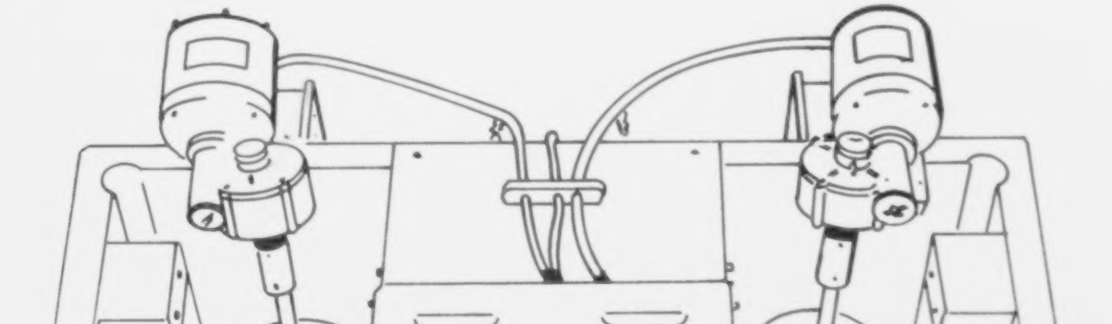

Figure 1-5. Electrolytic silver recovery unit.

silver from fixing baths. Because of its economy and convenience, steel wool is the most often used.

The acidity of the fix is an important factor when you use steel wool to recover silver. Iron dissolves readily in acid solutions, and once it is dissolved, it no longer reacts with silver ions. Too strong an acid solution, therefore, results in the loss of some of the steel wool. However, some dissolution of the iron by the acid fix is desirable because the etching action of the acid exposes new surface area to the solution. Moreover, excess alkalinity slows the replacement reaction.

Fortunately, the pH of most fixes is within the range for good utilization of steel wool. Below a pH of 4, the dissolution of the steel wool is too rapid. Above a pH of 6, the replacement reaction is so slow that an excessive amount of silver may be lost due to the long reaction time required to recover the silver.

After removal of the silver by metallic replacement, the spent fixing bath must be discarded. This effluent is highly contaminated with iron and has no further photographic use.

Since the advent of the silver recovery cartridge, shown in figure 1-6, the metallic replacement method of reclaiming silver has gained widespread acceptance. The cartridge is easy to use and effective. Fixing flows solution ~~is pumped~~ through the cartridge and the silver collects on the steel wool. After it becomes laden with silver, t~~he used steel wool can be replaced with fresh~~ the expended silver recovery cartridge is replaced. The metallic replacement system is ideal for low volume photographic facilities that generate fewer than 30 gallons of exhausted fixer ~~hypo~~ solution per 8-hour day. These activities include medical and dental X-ray laboratories, photographic hobby shops, and small base photographic laboratories. All mobile facilities can be served by this system.

Chemical precipitation. By adding certain chemicals such as sodium hydroxide to the solution, silver is precipitated from the fixing bath in the form of sludge that is dried and refined to reclaim the silver. The fixing solution must be discarded after using this method. This method is not recommended for Air Force use due to facility and manpower requirements and because of the noxious fumes and odors it generates.

Exercises (608):

1. Explain the effect that silver recovery has on the two types of fixing baths used in the Air Force.

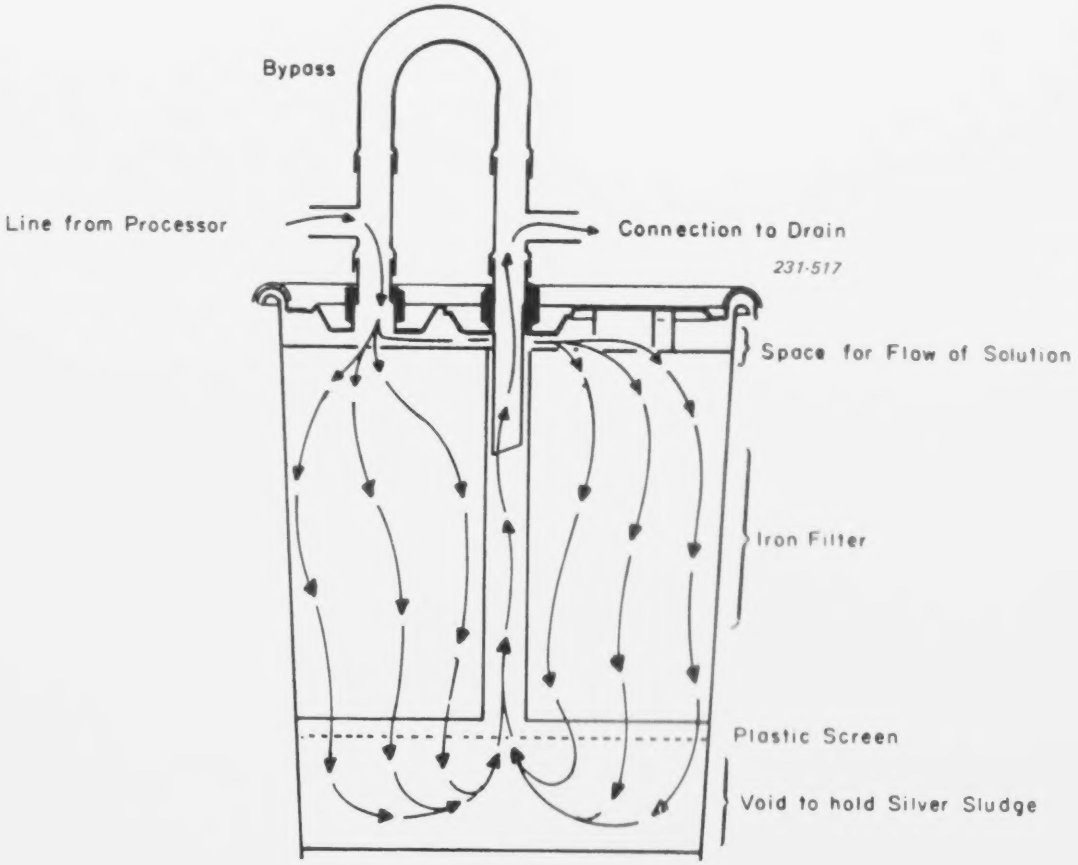

Figure 1-6. Silver recovery cartridge.

2. What is the advantage of the electrolytic method of silver recovery?

3. Under what conditions is the metallic replacement method ideal?

4. What are the drawbacks in the chemical precipitation method?

609. Specify the methods that can be used to recover silver from black-and-white film.

Methods of Silver Recovery from Black-and-White Film. There are currently two methods for recovering silver from processed and unprocessed film and paper remnants. These are:

Incineration. In this method, the film is reduced to ash under controlled conditions. The material is placed in a burner to control temperature not to exceed 1,700° Fahrenheit (934° C) since higher temperatures bring about vaporization of the silver. To comply with pollution abatement standards, control of emission is also essential. After it is recovered, the ash is further refined by smelting.

Emulsion stripping. Film strippers are designed to remove the residual silver from photographic negative, sheet, or rollfilm base. The strippers utilize a chemical solution which converts the silver in the emulsion back to a halide state. This method is generally considered more expensive than reducing the film to ash, but it has the advantage of conserving the film base for reuse or sale.

Exercise (609):

1. What two methods are used to recover silver from black-and-white film?

1-5. Operator Maintenance

The chemical mixing area of your photo lab is a lot like a kitchen. A kitchen is where all the food is prepared for the hungry people. The chemical mixing area is where nearly all of the processing solutions are prepared. They both must be kept neat and clean and all of the utensils must be kept in working order.

610. Specify procedural characteristics related to chemical mixing area operator maintenance.

Just like a kitchen, the chemical mixing area should have certain areas that are for specific jobs, such as mixing, measuring, and storage.

Storage. When you store chemistry, there are common sense guidelines to follow. Bulk and packaged chemicals should be stored on shelves or in cabinets. Place the heavy items on low shelves and the light, less bulky items on the higher shelves. Hazardous and caustic chemicals should also be stored on the lower shelves in a locked cabinet.

All of the stored solutions should be marked so that everyone knows what is in each container. You may mark each storage area also so that you do not store fixers with the developers.

Each mixing utensil should also have a proper storage place. Whether it is an A-1 mixer, a funnel, or a stirring rod, each mixing item should be kept in its own place. Clean each item before you put it away.

Measuring. Just like a cook who uses a measuring cup, you will use a graduate to measure quantities of solutions. You may also have to measure and weigh dry chemicals. Chemical weighing balances are precision devices and must be protected from damage. They should be kept on a clutter-free work surface, and once positioned they should be left in place. When you are not using the balance, cover it with its plastic cover. The individual weights used with the balance should be handled with care also. Do not drop them. The very smallest weights should be handled with tongs or gloved hands to prevent fingerprint corrosion.

Graduates should be cleaned and properly stored. Glass graduates can be cracked or chipped. Therefore, check that yours are not broken. A small piece of glass in the developer may scratch the film or, worse yet, cut your finger. Plastic graduates and containers will not break but sometimes they will stretch. A plastic graduate that is stretched out of shape will not allow you to make accurate measurements.

You will probably have thermometers in the chemical mixing area. These, too, occasionally need to be checked. One very accurate thermometer should be kept aside and used only for checking the accuracy of the other thermometers. You may find a thermometer which has a separated mercury. If this is the case, you can usually fix it by carefully heating the bulb. When the separation has expanded into the top of the glass tube, remove the heat. This operation will generally reunite all of the mercury.

Use thermometers to measure temperature. Do not use them for stirring rods or bottle openers.

Mixing. Keep the mixing area clean. A spilled solution should be wiped up immediately. A wet spot on the floor could become a very slippery spot.

You may have a chemical mixing unit such as the A-1 Mixer/Distributer. Before you plug in your mixer, be sure there are no loose or frayed electrical connections and cords. Be sure your hands are dry and you are not standing in a wet spot before you plug in the mixer.

Assuming you did not get fried when you plugged in the mixer, your next step is to rinse it out before you start mixing fresh chemistry. This will allow you to see if it is working properly and ensure the unit is clean. Run the unit in the mix and transfer modes. Drain it and begin to mix your chemistry. When you are done, rinse it again, using the mix and transfer modes once more.

Clean the external parts of the mixer with a sponge and water. Do not scrub stainless steel parts with abrasives or scouring powder. This may cause the stainless steel parts to rust.

Holding tanks should have tight-fitting covers, and the covers should be in place at all times to prevent oxidation and contamination of the solutions.

As you can tell, operator maintenance in the chemical mixing room is generally common sense and cleanliness.

Exercise (610):

1. Complete the following statements by supplying the missing term or phrase.
   a. When you store packaged chemistry, you should store the ____________ items on the lower shelves.
   b. Hazardous or caustic chemicals should be stored in a ____________ cabinet.
   c. Once a balance has been positioned, it should be ____________ ____________ ____________.
   d. You can usually repair a thermometer with a separated mercury by ____________ the bulb.
   e. Before you plug in a mixer, be sure your ________ are ____________.
   f. To flush out a mixer you should fill it with ____________ and then run it in the ____________ and ____________ modes.
   g. Tight-fitting covers on holding tanks will prevent ____________ and ____________.

CHAPTER 2

Black-and-White Film Processing and Finishing

AS AN AIR FORCE photographer, you must realize that the composing and exposing of a scene is no assurance of a top-notch photograph. The quality of the finished print is dependent to a great extent on the quality of your darkroom work. A perfectly exposed negative is useless if it is fogged, scratched, or reticulated during processing. It is, therefore, very important that you master film processing and finishing.

Every step in the photographic cycle is important. We don't intend for you to become a "fixer." We want you to become an accomplished photographer and film finisher. Although we do present methods of perfecting your product with after-the-fact finishing techniques, we really intend for you to produce a good product on your first try.

In this chapter, we present the information that will lead you toward becoming that accomplished photographer.

2-1. Film and Developer Combinations

Burns and Allen, Lewis and Clark, salt and pepper; these are all well-known combinations. Tri-X and DK-50, 35mm Plus X and Acufine should also be familiar to you. These are film and developer combinations.

You must know which films and developers are compatible because the type of film and developer you use will have an effect on your final product. Improper selection of developer and film will produce undesirable results. In this section we present the things you need to consider when selecting film and developer combinations.

611. Given film, developer, and descriptive uses, determine which combinations would produce acceptable results.

There are many different types of developers available. Each of them is designed to produce specific results. Your problem in choosing a developer is to pick one that produces a satisfactory image; one that retains most of the values and contrast of the original scene without the appearance of grain.

Developers for panchromatic film can be classified by the way that they affect the inherent grain size of the film being processed. Some developers affect grain size more than others. There are general purpose developers that produce medium grain. Fine grain and ultra-fine grain developers are also available. The whole idea is for you to match the developer to the film.

You can produce a negative with reasonable grain size by using a general purpose developer such as DK-50. Finer grain images can be achieved by using the same film and processing it in a fine grain developer. The problem here is that you will lose some contrast.

The size of the grain becomes important when it can be seen and is objectionable. The unaided eye usually cannot see grain in a negative. It is only when a projection print is made from the negative that the grain can be seen. A grainy negative produces a "pebbly" look to the printed image. Grainy prints are almost always objectionable and should be avoided.

The size print that must be made from a negative decides whether grain will become apparent in the print. Small negatives must be enlarged much more than large negatives to make the same size print. If you had two negatives of the same scene, one 4 X 5 (10 X 13 cm) and one 35mm that were processed in a general purpose developer, there would be an obvious difference in an 11 X 14 inch (28 X 36cm) print. The small negative would produce much more grain than the large negative. This is because the small negative must be enlarged more than the large negative to make the same size print. When you enlarge the image, you also enlarge the grain.

The best way to assure a fine grain negative is to use a fine grain film, and subsequently process it in a fine grain developer.

Fast films have inherently larger grain and lower contrast than slow speed films. It should be remembered that film developers cannot reduce the inherent grain size of any film. They can only prevent the grain size from becoming appreciably larger. Fine grain developers do not enlarge grain size as much as general purpose developers.

When you prepare for an assignment, consider the size of the prints that you must make from the negatives and then select the film and developer accordingly. As a general rule, process 120 and smaller negatives in fine grain developers; process negatives larger than 120 in general purpose developers.

Table 2-1 lists some films, developers, and their purposes. Although not by any means complete, this table should give you some good starting points and general guidelines in film and developer selection.

Exercises (611):

1. In terms of constrast and tone values, describe an acceptable negative.

2. When is grain size most noticeable?

3. Why does an enlargement from a small negative appear to be grainy?

4. Which of the following statements are true?
   a. 4 x 5 negatives processed in D-19 will have high contrast.

   b. 35mm negatives processed in Acufine will have fine grain.

   c. Process large negatives in D-76 to get high contrast.

   d. Ultra-fine grain can be achieved in small negatives by processing them in Autofine developer.

   ~~e. Ansco (GAF) 17 developer is an all around general purpose developer.~~

2-2. Film Processing

Most of the film processing done by base photo labs is manual film processing. Machine processors are available but are only used by labs that do a very large volume of work. Hand processing is a very satisfactory method of processing film, provided you use standardized techniques and the utmost care in handling the film.

612. Distinguish between the different types of film processing procedures.

As illustrated in figure 2-1, you are likely to encounter a number of different types of films to process. Except for Polaroid, which has a "built-in" processing system, you should be able to hand process all of the other kinds. Film is classified into two broad types: sheet film (individual cut pieces of film) and roll film. Let us now briefly look at how these types of film are processed.

Sheet (Cut) Film. Sheet films may be processed in either trays or tanks. Although tray processing is satisfactory, it is recommended for only small amounts of film. Normally, tank processing is more uniform for large numbers of sheets. With this method, each sheet of film is retained in a hanger, which is placed into a tank. Regardless of the method used, great care in handling is necessary in order to prevent scratches and to insure even processing from sheet to sheet.

Roll Film. Roll film is processed by using spiral reels and tanks. The film is wound onto a spiral reel. The reel is then placed into a tank for processing. The key to getting started is winding the film onto the reel in the proper manner.

Exercises (612):

1. What is the preferred method of processing large amounts of sheet film?

2. How is roll film processed?

613. State principles, procedures, and nomenclature associated with safelights.

Safelights for Film Processing. Now that we are starting to get into darkroom operation it is important to understand the purpose of safelights. It may come as a surprise to you that not all darkrooms are "dark." Depending upon the material that is being handled, it may be possible to have lights on. These lights are called safelights.

The function of a safelight is to transmit the maximum amount of light that can be used safely without damage to the sensitized materials being handled. Since the color sensitivity of different photographic materials varies, the color and intensity of the light must vary accordingly to be safe. Therefore, a photographic laboratory safelight is a combination of a rated light source and the designated filter to protect a specific sensitized material.

The following safelight filters are the ones most commonly use during black-and-white film processing (the numbers are Kodak Wratten designations):

TABLE 2-1
FILM AND DEVELOPER COMBINATIONS

WHEN YOU HAVE	AND YOU DESIRE	THEN USE THIS DEVELOPER (OR ITS EQUIVALENT)
SMALL AND MEDIUM SIZE FILMS (35mm, 120 ETC.)	A GENERAL PURPOSE DEVELOPER	D-76 HC 110 FG7
	A FINE GRAIN DEVELOPER	MICRODOL-X MICROPHEN
	AN ULTRA-FINE GRAIN DEVELOPER INCREASED FILM SPEED, OR BOTH	ACUFINE UFG MICROPHEN
LARGE SIZE FILMS (4 X 5, 8 X 10 ETC.)	A GENERAL PURPOSE DEVELOPER	DK-50 POLYDOL
	FINE GRAIN	D-76 HC-110 FG7
	A HIGH CONTRAST DEVELOPER	D-11 D-19

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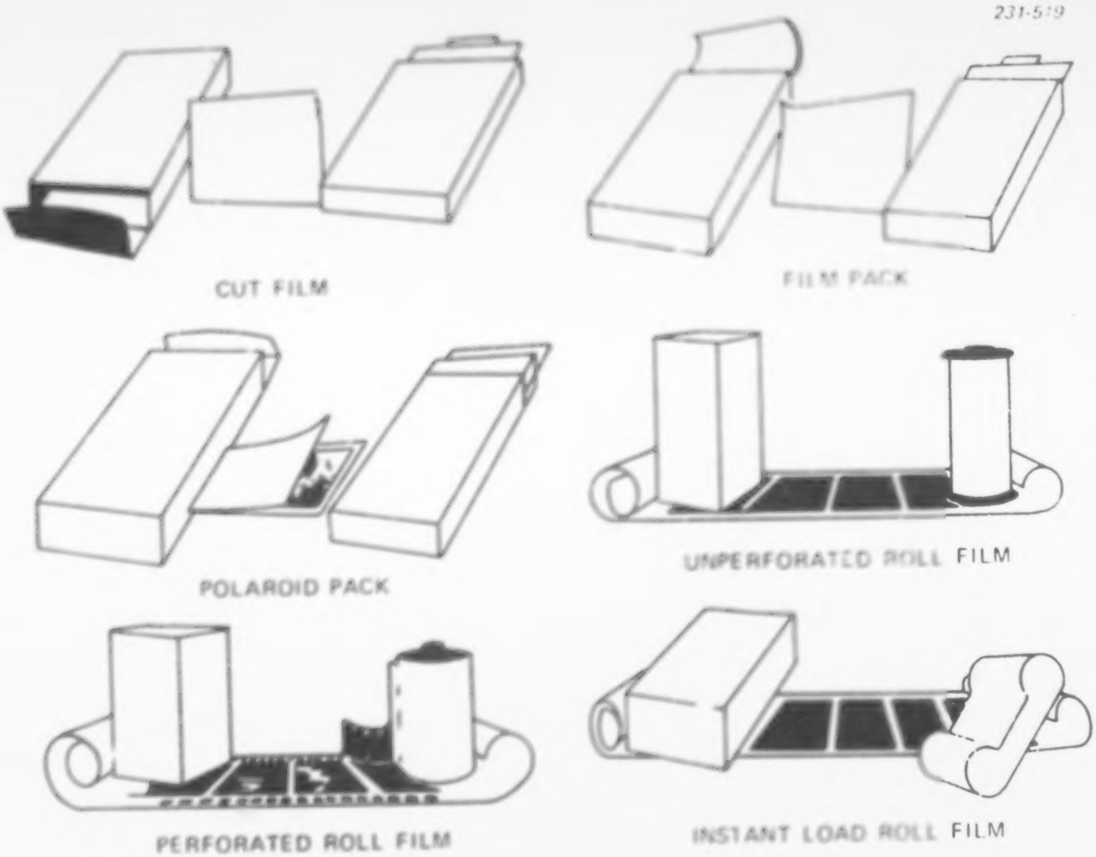


Figure 2-1. Film packaging.

Filter No.	Color	Use
1	Red	Blue sensitive films.
1A	Light Red	Orthochromatic copy films.
2	Dark Red	Orthochromatic film.
3	Dark Green	Panchromatic film.
7	Light Green	Infrared film.

When using a safelight, keep the following in mind:

(1) Install only the size of incandescent bulb specified by the manufacturer. If you use too large a bulb, the heat may damage the safelight filter or be too bright to be safe.

(2) Make sure that the safelight is properly grounded and that any wiring is kept far away from the processing solutions.

(3) Be sure the proper distance exists between the safelight and the processing area. Consult the manufacturer's instructions for proper placement.

(4) Handle the film under the safelight in the correct manner. (For example, for processing panchromatic film, the use of the green safelight is limited to intermittent use or to use only after several minutes of processing in total darkness. As always, follow directions in order to insure quality results.)

It is a good idea to perform periodic safelight tests to make sure that your materials are not fogged. The test can be performed in the following manner:

(1) Place a sheet of unexposed film on a working surface in the processing area.

(2) Place one or more small opaque objects (e.g., coins) on the emulsion and, with the safelights on, leave the film for twice the time that it would normally be handled.

(3) Process normally and check to see whether there is less density in the areas covered by the opaque objects. Less density would indicate fogging of the film by the safelight.

A safelight that causes fogging can be corrected by replacing the filter, installing a lower-rated bulb, or increasing the distance between the safelight and the material.

Exercises (613):

1. What is the purpose of a safelight?

2. Match the appropriate safelight filter number in column A with the appropriate film in column B.

Column A	*Column B*
_____ a. 1.	(1) Orthochromatic film.
_____ b. 2.	(2) Infrared film.
_____ c. 7.	(3) Blue sensitive film.
_____ d. 3.	(4) Panchromatic film.

3. Why is it important not to use too bright a bulb with a safelight?

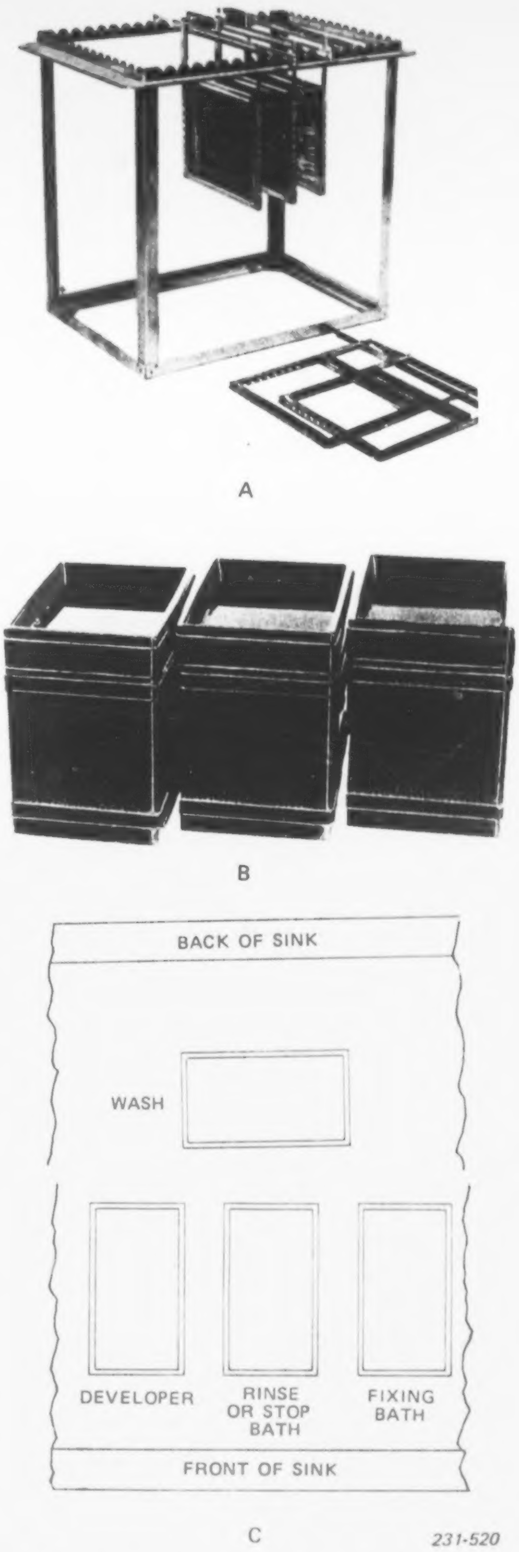


Figure 2-2. Equipment for tank processing sheet film.

614. Explain procedures in using tanks and hangers for the processing of sheet film.

Tank development is recommended for processing a number of sheets of film at one time. The tanks filled with the appropriate solutions are deep enough to completely cover the films. The individual sheets are supported by film hangers. By using the tank method, you will find the solutions last longer and you will be more assured of even processing. Figure 2-2 shows the equipment needed for tank processing sheet film.

Loading Sheet Film Hangers. A film hanger is simply a channeled frame suspended below a bar. The bar is long enough to reach across the tank and allows the frame to hang below the surface of the solution (see fig. 2-3). The frame has channels on the bottom and both sides, as well as a hinged channel across its top. Each hanger normally holds one sheet of film. The hangers are manufactured in the normal sheet film sizes such as 4 x 5, 4 x 5 film pack, 5 x 7, and 8 x 10 inches.

The darkroom should be arranged to provide a clean loading area. The hangers should be kept on a special bracket to be easily reached. Loaded hangers can be placed on another bracket.

For loading, spring back the hinged top channel of the hanger so that the side channels are exposed. Hold the hanger in one hand, and pick up the film with your other hand. Insert the film into the hanger so that the edges slide into the channels; it may be necessary to tap the back of the film lightly with your fingers to make sure that the film falls into the bottom channel. Spring the hinged top back into place.

You may prefer this other method of loading. First, spring the top channel halfway back. Next, instead of sliding the film into the sides, place most of one edge in the left-hand channel and curve the film slightly so that the opposite side will spring into the right-hand channel. Only a slight drop is then required for the film to slide into place. Finally, snap the hinged top closed and give the hanger a slight shake to see that the film is free in the channels and has not been pinched or buckled.

Developing Sheet Film. Once the hangers are loaded with film, lift all of them by their crossbars and lower them into the developer simultaneously with the starting of the timer. This procedure insures uniform agitation and even development. The immersion should be done slowly and smoothly to prevent splashing and the formation of air bells.

Once the hangers are in the developer, strike them sharply against the sides of the tank to dislodge any air bells that may have formed. Leave the hangers undisturbed for 1 minute, and then agitate all of the hangers for 10 seconds, following the pattern illustrated in figure 2-3. Continue the agitation pattern of 10 seconds per minute for the remainder of the development time.

At about 10 seconds prior to the completion of the development time, lift the hangers out of the tank and allow them to drain. Then transfer the hangers into the stop bath and agitate them continuously for about 30 seconds. Drain them and then transfer them into the fixing tank. Continuously agitate them in the fixing bath for the first 2 minutes and then continue agitating on a 10 seconds-per-minute basis for the remaining fixing time. Drain the film again and transfer the hangers to a water rinse, agitating them for about one minute — lifting and draining them during the last 10 seconds. Transfer the hangers to the hypo clearing bath and agitate for the first 30 seconds then leave the film in the clearing agent for a total of two minutes.

Drain the sheets again and transfer them to the wash tank. When washing is completed, remove the hangers from the wash tank and immerse them in a film wetting agent. Film wetting agents reduce the surface tension of water so that when the film is hung up to dry the water drains off the film surface without beading up. This prevents the occurrence of water spots on the dried film. No agitation is required in the wetting agent and the film can be removed after one minute. Remove each sheet of film from its hanger and hang the film up to dry.

Exercises (614):

1. Why is tank and hanger processing of sheet film better than tray processing?

2. How does a film hanger work?

3. In what manner should the hangers be immersed in the developing tank? Why?

4. Briefly explain the pattern for agitating film.

5. What chemical solution is the film immersed in after fixing?

615. Explain procedures used in the reel and tank processing of roll film.

Developing Roll Film. It is far more convenient and reliable to develop roll film in a small tank than in a tray. The design, detail, and construction differs somewhat among the various manufacturers' models of tanks, resulting in differences in loading and use. Generally, the basic unit, as illustrated in figure 2-4, consists of a spiraled and grooved reel to hold the film, a tank with a light-tight cover, and a filler cap. Each reel is constructed for a specific size roll of film. The tank top permits pouring the chemicals in and out in the light. Normally, all the parts are made out of stainless-steel or plastic.

The proper loading of the film reel in total darkness is one of the most important steps and a challenge to the beginner. First, make sure that both the reel and your hands are clean and dry before loading. Then remove the film from the cassette (35mm or 70mm) or separate it from the paper backing (120 or 220). The film must be handled by its edges in order to prevent fingerprinting and scratches. (When working with 35mm, the tongue of the leader must be cut off to make a square end prior to loading.) Next, attach the film to the core of the reel, with the emulsion facing inward. Turn the reel while applying a gentle pressure with the thumb and forefinger on the edges of the film. This pressure will produce a slight curl in the film and allow it to pass between the grooves of the reel. Apply enough tension to the film so that it will not skip grooves. However, excessive tension can cause the film to overlap in the grooves. (This skill is best practiced in the light a few times with dummy film.)

Once you have the reels loaded properly, you can think about processing. Although all tanks have provisions for pouring in the solutions after the film is inside, it is best to have the tank already filled with developer. This prior preparation insures more even development. Start the timer, place the loaded reel in the tank, put on the top and cap, and then briskly agitate for a few seconds to break any trapped air bells. (Once the top is on, the remaining steps can be done in the light.) You then continue processing for the required time with the correct agitation.

During the last 10 seconds of the developing time, the solution can be poured out of the tank through the light-trapped pouring hole. Fill the tank with water or

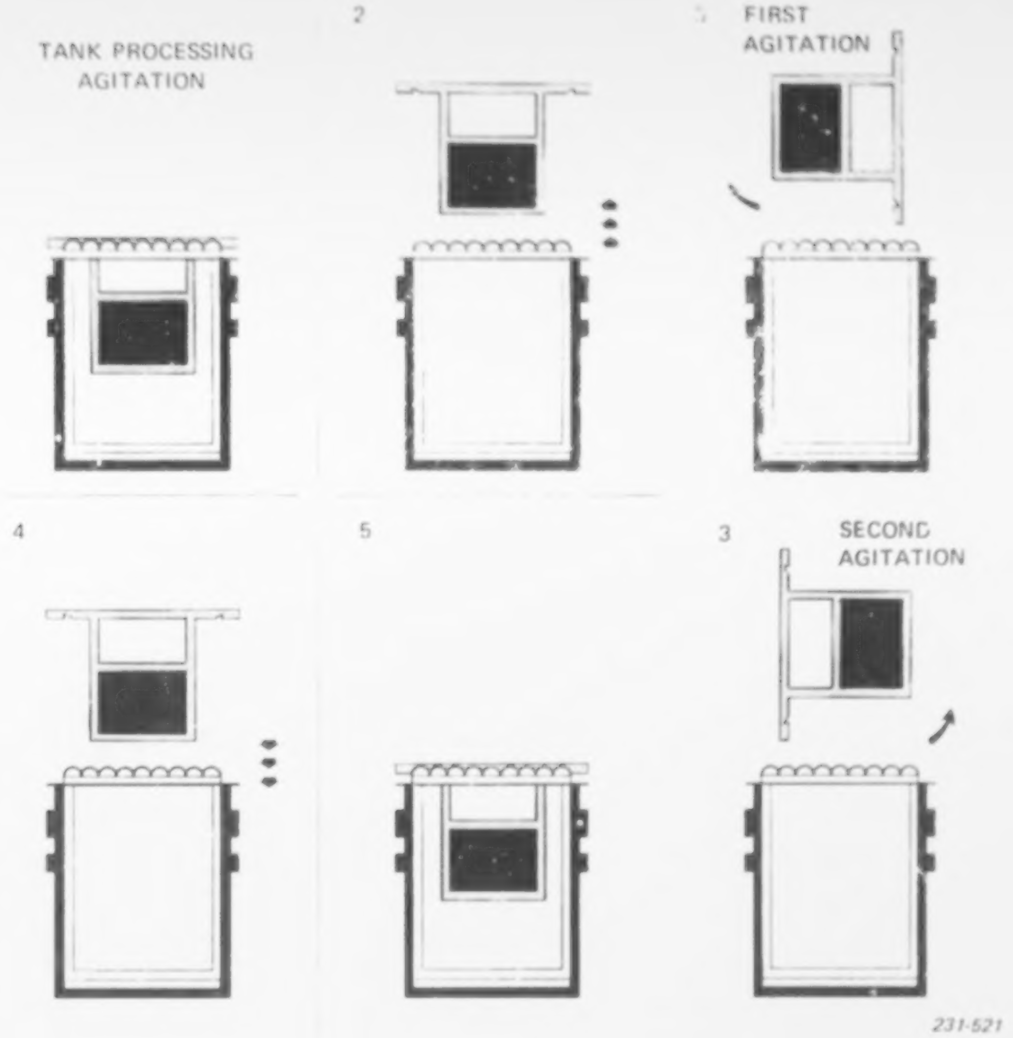


Figure 2-3. Sheet film agitation.

stop-bath solution and agitate for 30 seconds to a minute. Then pour out the solution and pour in the fixer. Agitate the film continuously for 1 to 2 minutes and then agitate the film at required intervals during the remaining fixing time. Pour out the fixer and wash the film by removing the tank cover and running a continuous stream of water into the tank for about 20 minutes. Once the washing is completed, bathe your film in a wetting agent such as "Photo-Flo" prior to drying. This technique reduces the chance for water spots. Also, when drying roll film, make sure that you use a clip at the free end to prevent curling.

Exercises (615):

1. Why is it important to apply just the right amount of tension when you are loading roll film on a reel?

2. Why is it important to fill the tank with developer solution prior to dropping in the reel?

3. How can you help prevent curling when you are drying roll film?

616. State the relationship of time and temperature to film development.

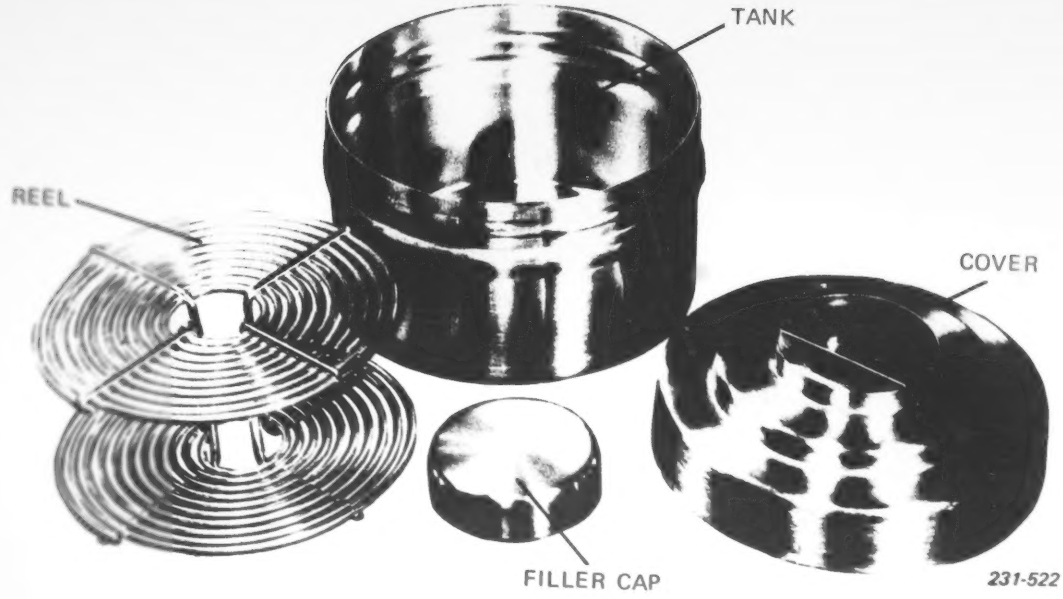


Figure 2-4. Stainless steel roll film tank and reel.

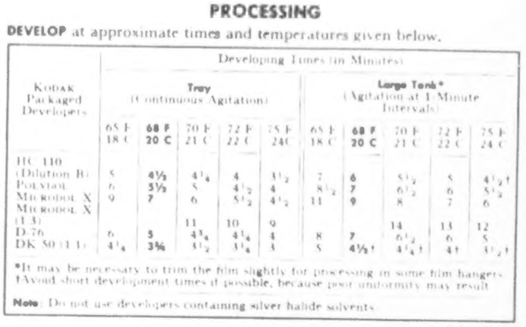
Time/Temperature Factors. Many factors must be considered if you want to insure correct film development. Two of these are the time of development and the temperature of the developer.

Control of the processing time and developer temperature is essential to correct processing. If the film is developed for too short a time or at too low a temperature (or a combination of the two), a weak low-density negative will result. Underdevelopment causes a loss of detail in the shadow portion of the negative and reduces contrast. On the other hand, if the negative is developed for too long a period or at too high a temperature (or both), the result is overdevelopment. An overdeveloped negative has useless density, blocked up highlights, and too much contrast. By following a time/temperature chart (illustrated in fig. 2-5) supplied with your film or chemicals, you can establish the correct combination that will produce printable negatives. (NOTE: The exact processing time will also be affected by your method of processing. Make sure that the time/temperature chart you use applies to the type of film and processing method you are using.)

Normally, temperature is maintained at 68° F., (20° C.) and the time of development is varied to produce the desired results with the particular film/developer combination. There are several reasons for this standardization. At a temperature of 20° C., the gelatin swells sufficiently to allow adequate penetration of the developing solution without softening to the point where the emulsion is easily damaged (which occurs at higher temperatures). Temperatures lower than 20° C. tend to slow development excessively. Only when time is of the utmost importance are high temperatures used. (High temperature processing is a feature of machine, rather than hand, processing.)

When you know the time/temperature relationship for a given film/developer combination, processing in total darkness is relatively simple. You adjust solutions to the prescribed temperature and then process for the required time. Assuming proper exposure, time/temperature processing can consistently produce satisfactory results.

Time/temperature processing is a giant step over the old inspection method. The inspection method required checking the negative density under an appropriate safelight. This called for a very experienced eye in order to obtain consistent results. However, this older method is still used in the processing of some copy films.



PROCESSING

DEVELOP at approximate times and temperatures given below.

Kodak Packaged Developers	Developing Times (in Minutes)									
	Tray (Continuous Agitation)					**Large Tank*** (Agitation at 1-Minute Intervals)				
	65 F 18 C	**68 F 20 C**	70 F 21 C	72 F 22 C	75 F 24 C	65 F 18 C	**68 F 20 C**	70 F 21 C	72 F 22 C	75 F 24 C
HC-110 (Dilution B)	5	**4½**	4¼	4	3½	7	**6**	5½	5	4½†
Polydol	6	**5½**	5	4½	4	8½	**7**	6½	6	5½
Microdol-X	9	**7**	6	5½	4½	11	**9**	8	7	6
Microdol-X (1:3)			11	10	9			14	13	12
D-76	6	**5**	4¾	4¼	4	8	**7**	6½	6	5
DK-50 (1:1)	4¼	**3¾**	3½	3¼	3	5	**4½†**	4¼†	4†	3½†

*It may be necessary to trim the film slightly for processing in some film hangers.
†Avoid short development times if possible, because poor uniformity may result.

Note: Do not use developers containing silver halide solvents.

231-523

Figure 2-5. Sample time/temperature chart.

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All solution temperatures (developer, rinse, fixing bath, and wash) should be as near to each other as possible. If there is considerable difference in the temperatures between solutions, the emulsion is subjected to excessive expansion and contraction, which may cause it to wrinkle or crack. This effect is called reticulation. Normally, this permanent defect renders the negative useless for printing.

Exercises (616):

Complete the following statements related to time/temperature factors in development:

1. During development, negative density increases with both ______________ and ______________ increases.
2. An overdeveloped negative has ______________ density.
3. The normal development temperature is ________ °C.
4. High processing temperatures can cause excessive ______________ of the emulsion.
5. Time/temperature processing is more reliable than the ______________ method.
6. If there are wide differences in the temperatures of processing solutions, you may get ___________ .

617. Describe the principles and techniques of the hand agitation of film.

Agitation. As we discussed different methods of processing we have indicated the need to agitate the film in each processing step. The technique of agitation is therefore very essential.

The act of moving a photographic film in a processing bath or moving the bath relative to the photographic material during processing is called agitation. The purpose of agitation is to cause a more rapid exchange of the used solution absorbed into the film and the fresh solution from outside the film.

During development, the fully exposed areas of the film (highlights) exhaust the developer faster than the middle tones or shadows because there is a higher percentage of exposed halides to be reduced. If there is not adequate agitation, the highlights will not be as fully developed, relative to the middle tones and shadow areas. For the same reason, the middle tones will not be fully developed. The result is an underdeveloped negative that lacks a good tonal scale, detail, and contrast. Over-agitation causes the opposite problem. Overdevelopment increases contrast and blocks up the highlights. Proper agitation, as recommended by the developer instructions, insures an adequate exchange of fresh for exhausted developer, which results in adequate detail, contrast, and tonal range.

While we have emphasized the importance of agitation in the developer, correct agitation is important in each processing step in order to insure a continuing exchange of fresh for exhausted chemicals over the film surfaces.

Methods of Agitation. Though we have mentioned agitation as we discussed each method of processing, it is a good idea to review the different types of techniques that can be used.

Agitation of sheet film in a tray. If you are processing only a single sheet, one good agitation method is to tilt the tray so that the solution accumulates at one end. Slide the sheet of film emulsion up in at the opposite end of the tray and as you do so, level the tray so that the solution comes in over the sheet of film. Then agitate by rocking the tray, lifting each corner of the tray in a rotational sequence starting with the lower left end and going to the lower right, upper left, and upper right. This rotation insures an adequate cascade effect over the film. Tray agitation is normally continuous except for the latter stages of fixing.

When you are processing a number of sheets of film, the above method will not work. Instead, you transfer each sheet, emulsion side up, into the tray, making a stack. Then you rotate each sheet from the bottom to the top throughout each step. Because this method requires constant handling of the film, care must be exercised in order to prevent scratches. Practice holding the film by its edges to reduce the chance of harm.

Agitation of sheet film in a tank. First, make sure that you are not trying to develop too many sheets at one time. There should be adequate space around each hanger in the tank. Once you are ready to agitate, follow these steps (review fig. 2-3):

(1) Lift the batch of hangers straight up out of the solution. Tilt them almost 90° to the left. Return the hangers to the solution.

(2) Lift the hangers out again, and then tilt them almost 90° to the right. Return the hangers to the solution.

Normally, agitation in tanks is 10 seconds of every minute or 5 seconds of every 30 seconds.

Roll-film tank agitation. Tank agitation of roll film follows the standard tank pattern of 5 seconds every 30 seconds or 10 seconds every minute, the exact method depending on the film/developer combination. The method of agitating the tank depends on its construction. By following the directions, you will get proper results. Normally, a roll-film tank is agitated by inverting it and then returning it to the vertical several times.

Exercises (617):

1. What is the purpose of agitation?

2. A lack of adequate agitation in the developer causes what kind of negative?

3. How can you agitate several sheets of film in a tray?

4. What is the basic difference between tray and tank agitation?

618. Briefly explain how to produce a black-and-white positive.

Processing Black-and-White Positives. The purpose of making a black-and-white positive (transparency) is to obtain an image that is viewed by transmitted light instead of reflected light like a print. The steps necessary for processing black-and-white positives are identical to that used for negatives. The only difference is the type of film/developer combination that is used to obtain the image.

Black-and-white slides can be made by printing on film. Fine-grain positive films, like Kodak's Commercial Film 6127 or High Contrast Copy, are the best emulsions. Your black-and-white original negative is then contact printed onto the copy film. (We shall discuss contact printing in greater detail later in this volume. For the time being, we'll state that contact printing requires only that the negative and the film be held together emulsion to emulsion and that the film be exposed by passing light through the base of the negative. A contact printer, which is used to do this, is essentially a box that contains a lamp, a piece of glass upon which to put the materials, and a lid to hold them flat together.) The film is then developed according to directions, like the following:

Film	Development
High Contrast Copy	D-72 diluted 1:1, 6 minutes at 68° F (Tank – intermittant agitation).
Kodak 6127	DK-50, 2 minutes at 68° F (Tray – constant agitation).

After processing, the film is fixed, washed, and dried. After drying, the film is cut and then mounted. Glass mounts should be used so that the film will not buckle under the heat of the projector.

Exercises (618):

1. Briefly outline how a black-and-white positive can be made from an original negative.

2. Why should glass mounts be used for slides?

2-3. Film Finishing

Each step in film processing is vital and must be done properly. The final steps that make developed negatives permanent and usable are washing, drying, and retouching. Let's now cover each of these steps individually.

619. Complete statements regarding the principles and techniques of proper film finishing.

At this point in film processing you have taken your film through the development, fixing, and hypo clearing steps. If you did these steps properly you have a good-looking negative or group of negatives. To make those images permanent, the film must receive adequate washing. There are many different methods that can be used to wash film depending upon the apparatus that you have available in your lab. Film must be washed to remove the byproducts of fixation. If these byproducts are not removed they will eventually stain the negative making it unusable.

Washing Methods. Sheet film is washed according to the equipment used to process it. Sheet film processed in trays is washed in a tray, and sheet film processed in a tank is washed in a tank, etc. Small amounts of sheet film can be easily washed in a tray. The factors that affect wash time are the amount of film to be washed and how rapidly the water is exchanged in the washing vessel. A simple method of tray washing is to place a water hose in a tray allowing it to fill up and overflow. The film is placed in the tray of water and the rate of water flow should be enough to completely exchange the water in the tray every three minutes for a total of ten exchanges of water. The film being washed should be agitated every few minutes to keep individual sheets from adhering to one another. A better method of tray washing is to use a tray siphon. This apparatus siphons water from the bottom of the tray and lets fresh water in at the top. This is more effective because byproducts of fixation tend to migrate to the bottom of the tray.

Sheet film that has been processed by the hanger and tank method may be left in the film hangers for washing. A wash tank the same size as other processing tanks is used. The wash tank should have an outlet or outlets on the lower sides of the tank to carry out fixer-laden water. Some special wash tanks are available with a sliding gate which opens up one side of the tank from the bottom to allow water out. The gate can be opened to any position allowing you to control the outflow. Hard rubber tanks for washing can be made more efficient by drilling a series of small holes along the lower sides of the tank.

With either method, you must make sure that the negatives are separated so that a sufficient amount of fresh water reaches all areas of each negative. Keep in mind that the tray method can usually handle only a few sheets of film at a time.

Roll film may be washed by removing the tank cover and running a stream of water into the tank. You should insure that the tank is emptied every few minutes so that chemicals are not collecting at the bottom. A very efficient method is placing the reel into a specifically designed roll-film washer which consists of a tube in which the reel is placed and through which water is forced in at the bottom.

Regardless of the method you use, plan to wash your film at least 20 minutes unless otherwise directed.

Exercises (619):

1. If byproducts are not removed from the film during the wash they will ______________ the negative.
2. Small amounts of sheet film can be washed in a ______________.
3. Factors that affect wash time are the ____________ of film to be washed and ______________ ______________ the water is exchanged.
4. Water flow should be enough to exchange the water in a tray every ______________ minutes.
5. Your film should be washed for at least __________ minutes.

620. Briefly explain the purpose and use of wetting solutions.

The proper use of a wetting solution insures that your negatives will dry properly. Let us see how they work.

Purpose of Wetting Agents. After washing, water often drains from film in an irregular manner, clinging to both the emulsion and base sides in drops, streaks, and uneven patterns. If such partially drained or incompletely wiped films are subjected to vigorous drying conditions like hot air blasts or intense radiant heat, the areas under these streaks and drops of water dry much more slowly than the surrounding film. The swollen gelatin at these points is thereby subjected to stresses and shrinks unevenly, changing the density of the silver image. Even when surplus water is removed from the emulsion side, if drops of water remain on the base side, drying of the emulsion immediately opposite the water spots is retarded and drying marks may result.

Wetting agents lower the surface tension of liquids, thereby breaking down droplets of water. The film will thereby dry faster and more evenly. The common commercial wetting agents that are designed for photographic use include Kodak Photo-Flo, Edwal Kwik-wet, and Pako Pakowett.

Proper Use of Wetting Agents. A typical method is to bathe the film after washing for about 2 minutes in a 2-percent solution of the wetting agent. The exact concentration depends on the product being used. (About a quarter of a cap full of Photo-Flo in an 8 x 10 tray of water is sufficient.) Do not use too much wetting agent, as this can cause stains or a scum to form. Once the film has been bathed, drain it and sponge off the excess liquid.

Exercises (620):

1. Why should film be bathed in a wetting solution prior to drying?
2. Explain how to use a wetting solution.

621. State principles and procedures related to film drying.

Drying Film. Film drying is a simple task, but there are some important factors that affect film drying and you should be aware of them. There are two ways to dry film. One way is through natural evaporation and the other way is forced drying. We can relate drying by natural evaporation to hanging a load of wet clothes outside to dry. We have to depend upon the prevailing weather. If it is a warm, dry, sunny day, the clothes will dry very quickly. However, on a drab, cold day it will take a long time to dry them. Hanging your film up to dry in the lab and letting nature take its course will require at least 30 minutes or longer. There is no way to accurately predict how long it will take for the film to dry, because just as in drying clothes, drying time depends upon air temperature, relative humidity, and air circulation.

The proper method of drying your film by natural evaporation is to suspend the film on clips attached to a line. The room that you use to hang up your film should be as clean as possible and away from high traffic areas where the moving about of people causes dust to be stirred up. When film is still wet, it is very susceptible to dust. Dust landing on the film during drying will adhere to the film emulsion and become embedded.

The drying time for film can be reduced if you have a warm circulating air environment for your film. A film dryer provides this environment. Heated air can absorb more moisture and when the air is circulated around the film it reduces drying time. Film dryers are needed in areas where the relative humidity is high and also when you must dry your film quickly for a rush requirement.

Figure 2-6 shows a typical film dryer in the Air Force inventory. It is essentially an enclosed cabinet.

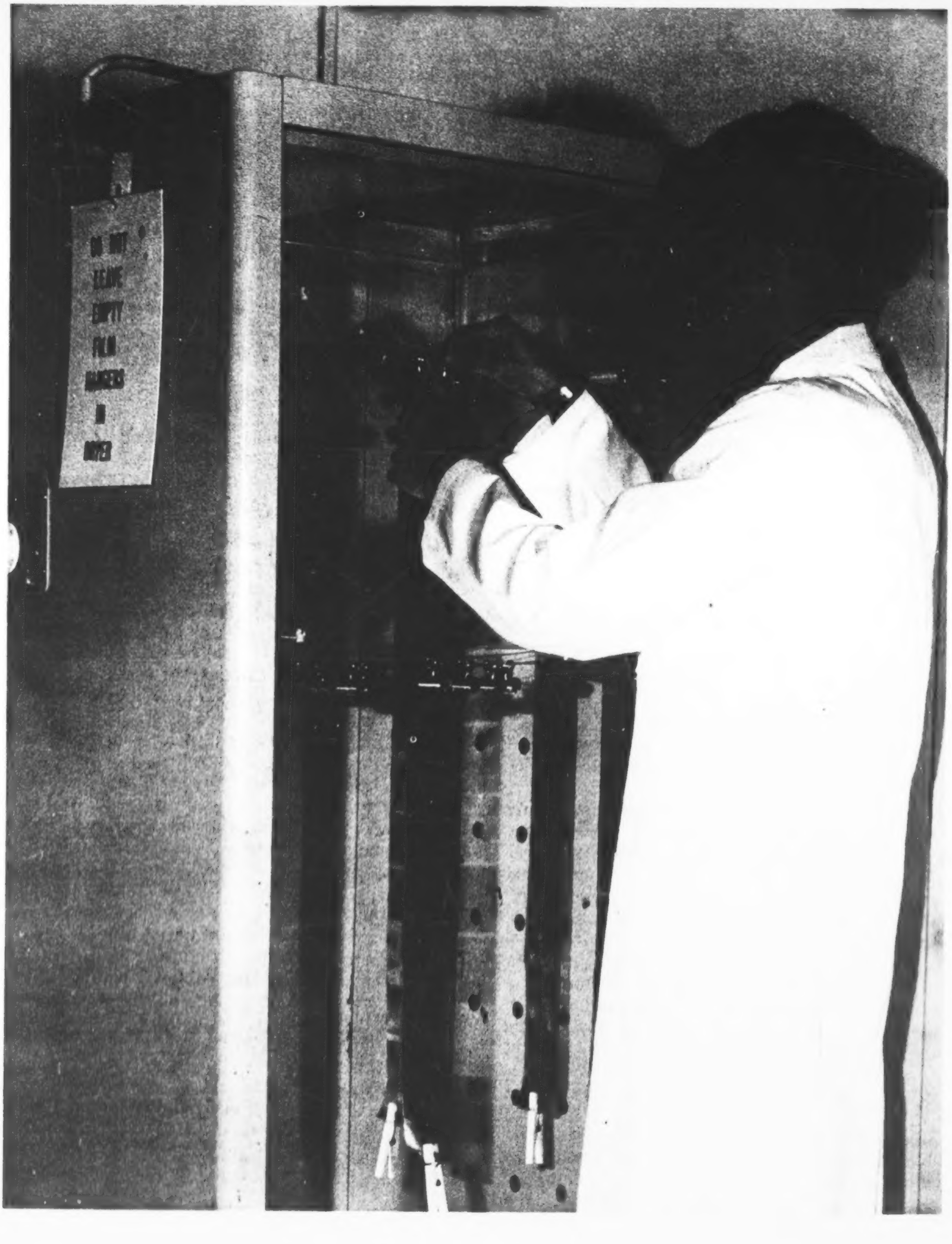
DO NOT
LEAVE
EMPTY
FILM
HANGERS
IN
DRYER

Figure 2-6. Typical film dryer.

Opening one of the doors to the drying chamber reveals strands of wire at the top of the chamber with film clips attached. There is a thermostatically controlled electrical heating element below the floor of the drying chamber. An air intake with an in-line blower draws fresh, filtered air into the bottom of the cabinet and across the heating element. The warmed air is then distributed throughout the drying chamber and it finally vents through the top of the dryer and can be exhausted to the outside of the building.

Use the following procedures whenever using a film drying cabinet to dry film.

(1) Hang your wet film up and squeegee it in the conventional manner.

(2) Turn the main switch to ON (fig. 2-7).

(3) Set the thermostat (fig. 2-7) to the desired temperature. This should not be higher than 125° F. (52° C.).

(4) When checking on the condition of your film during drying, always turn the blower motor off before opening the drying chamber doors to prevent dust from being ingested into the drying chamber.

Drying Problems. The primary problems of drying that you should guard against are uneven drying, dust, scratches, and emulsion damage due to using too much heat. It is important for you to keep in mind that warm air, not hot air, should be used to dry your film. Also consider the weather conditions. In humid weather, film will take longer to dry. If the air is dry, you probably don't need to use any heat. Try drying your film with the thermostat at its lowest setting and let the circulating air in the drying cabinet dry your film. You will be pleasantly surprised at what good circulation of the air will do. If your film is dried with too much heat, it will curl excessively making your negatives very difficult to handle when you print them.

Never leave your films in their processing hangers or reels to dry, because you will get uneven drying and drying marks. Always use metal clips at the bottom of roll films to prevent them from curling up during drying. Use the weighted, stainless steel type specifically designed for this purpose because they do not rust.

Dust and water spots on the film after drying are frequently encountered problems. Sometimes dust can be removed with a camel's-hair brush, but often it becomes imbedded in the emulsion. Rewash and dry the film if necessary. Water spots are circles or streaks of plus density and they usually cause permanent damage to the negative because they cannot be washed out. The best cure for these problems is prevention. Water spots can be avoided if you always use a wetting agent and carefully squeegee your film before drying.

Exercises (621):

1. How can you keep roll film from curling up during drying?

2. In dry climates how should you set the controls of your film dryer?

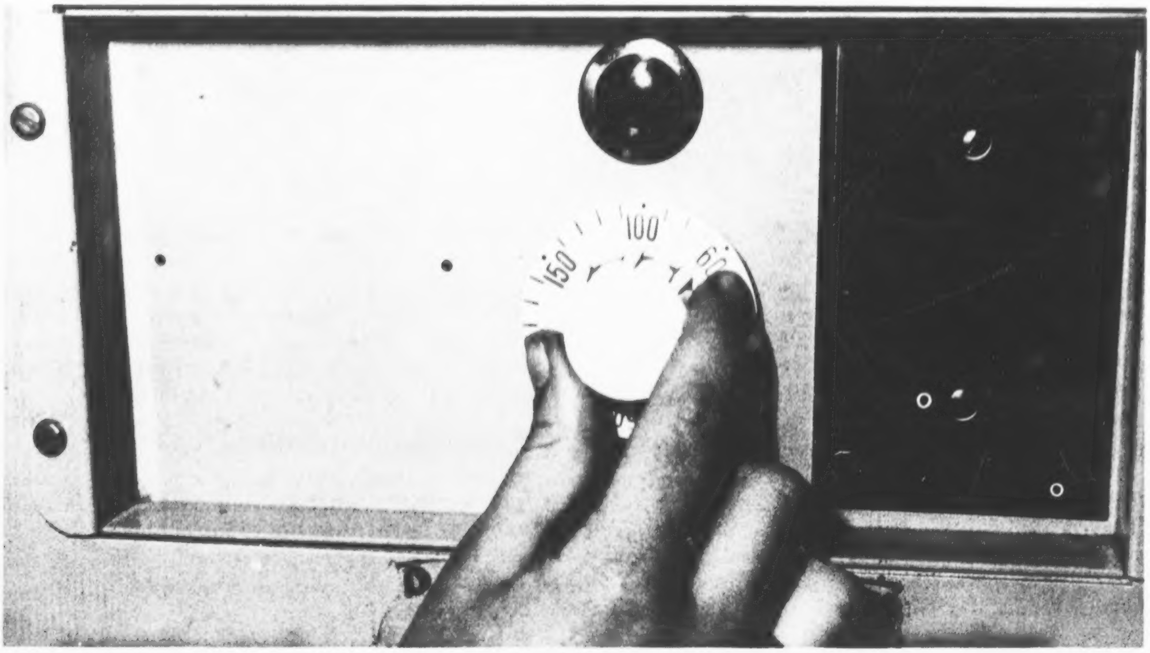

Figure 2-7. Film dryer controls.

3. What procedure would you use if you found dust on your negatives after drying?

4. What three factors control the rate of film drying?

5. What problem does the excessive use of heat during drying cause?

6. Why are water spots a serious problem?

622. State the purpose and indicate basic techniques of opaquing negatives.

Opaquing. The technique of opaquing is the act of covering undesirable portions of a negative with a light-blocking dye called opaque. When this procedure is used, the opaqued portions of the negative do not produce any density and are therefore white in a print. This technique is most often used to finish copy negatives to eliminate unwanted pinholes and low density areas.

Opaquing Techniques. There are two basic types of opaque that can be used. One type is number 1a red dye which is effective for blocking out backgrounds. The other is a water-soluble pigment, either red or black, that is good for eliminating localized low density areas such as pinholes and scratches. To opaque a negative you must have the proper working surface where the light comes from beneath the negative. A contact printer, X-ray lightbox, or plotting table are all equally effective for use as a working surface. To prevent eye fatigue, you should block off any light around the negative.

When using 1a dye, saturate a cotton swab to about half its length with the dye and apply it to the emulsion side of the negative, outlining the parts of the negative that you want to retain. Work slowly to allow enough time for the dye to absorb into the emulsion. With practice you will gain the experience to accurately outline the image. Sometimes it is necessary to block both sides of the image if the area you want to block is very thin in the negative. Very small areas can be dyed using a mapping pen. It is also common practice to outline the image with a mapping pen and then finish the job with a cotton swab or artist's brush.

Opaquing with 1a dye is permanent and must therefore be done very carefully. Errors can be removed if done quickly with a cotton swab and clean water. If you cannot completely remove the dye with this method try a 10-percent solution of sodium sulfite. All the dye can be removed completely by soaking the negative in the 10-percent solution followed by washing and drying.

When using water soluble opaque, water can be added to make it the desired consistency. It has the advantage of covering in one application. Use a small artist's brush to apply it and then only to the base side of the negative. This opaque is highly water soluble and can be washed off in water.

Exercises (622):

1. What is the purpose of opaquing?

2. Complete the following statements
   a. A pinhole that is opaqued on the negative appears ______________ on a print.
   b. Opaquing with water soluble opaque is done on the ______________ side of the negative.
   c. When you want to block a negative with a single application use ______________ .
   d. A 10 percent solution of ______________ will remove 1a red dye from a negative.

623. List the factors to look for when selecting negatives to be printed.

All of your work that went into exposing, processing, and finishing your negatives come to a halt when you must select the negative to be printed. Your supervisor will probably do this more than you. However, you should know what the supervisor looks for.

Focus. Obviously your negative must be in focus. Contrary to certain popular beliefs, there is no focusing solution.

Exposure. Your negatives must be properly exposed. Given a choice of over and underexposed negatives, choose the overexposed one. Underexposed negatives will not yield enough detail in the shadows to produce a good print.

Defects. Scratches, pinholes, dust, curl; anything that will detract from the printed image should be avoided. Choose the negative with the least number of defects. (Assuming you have to choose one with any defects at all).

Contrast. Choose the negative with the correct contrast. The negative should have a full range of densities. This should include the highlights, shadows, and middle tones.

Grain. If you processed your film properly you will not have too much grain. Remember that as you enlarge a negative the grain becomes more objectionable.

Identity. Those people or objects in the scene must be identifiable. Don't select a negative that will not produce identifiable subjects.

Pleasing. The goal of printing is to produce a pleasing picture. All of your selection factors must be based on whether the resulting print will be pleasing.

Exercises (623):

1. List five factors you must consider when selecting negatives for printing.

2. What is the ultimate factor to consider when selecting negatives for printing?

624. State principles and facts about lettering negatives.

In Volume 1 we covered lettering of negatives quite briefly. We go a little deeper in this section.

Remember that AFR 95-4, *Audiovisual Records Disposition Program* is the regulation that governs the lettering of negatives. It gives the following information:

(1) Letter in the widest clear margin on the base side. Information, starting from the left, must include, photograph number, calendar year, exposing unit, and classification.

(2) Numbers are assigned in sequence starting with number 1 on the first day of the calendar year.

(3) Exposures that are part of a sequential roll may be identified by adding, to the initial number for the first exposure, a letter suffix for each succeeding exposure in the sequence.

(4) For 35mm negatives in strips, assign the identifying number to each strip of four to six exposures. Write the number on a clear margin of the first exposure or on an attached leader or titling strip.

Regardless of the size of the negative do not letter on an important part of the negative.

Lettering can be done by freehand or by mechanical lettering devices. The whole idea is to make sure that the writing can be read.

You can use permanent or water based ink. The advantage of each is the disadvantage of the other. Permanent ink cannot be washed off, either purposely or accidentally. Water based ink can be washed off if you make a mistake.

Your lettering procedures should be done on a light table. Just as in opaquing, you should block off the surrounding light to reduce eye fatigue. You must also wear cotton gloves to protect the negatives from fingerprints.

After each lettering session, clean the pen(s) and work area.

Exercises (624):

1. Which regulation gives you lettering guidelines?

2. On what part of a negative should you letter?

3. What would be the number of the third exposure on a strip of 35mm negatives if the first exposure was number 307?

4. What is the advantage of using water based ink to letter negatives?

5. Why should you wear cotton gloves while you are lettering?

625. Indicate principles and techniques applicable to the handling and storage of negative material.

Handling and Storing Negative Material. Can you afford to have your precious negatives lie around after your efforts in shooting, processing, and finishing? Proper handling and storage of your negatives is just as important as carefully loading your camera to begin the photographic process.

Storage Problems. Moisture, strong light, and heat can damage any film. Processed films should therefore be stored on the main floors of buildings, never in basements, which may be damp, nor in attics, which may be hot. A relative humidity of 25 to 50 percent and a temperature of 70° F. (21° C.) or less are best. It must be emphasized that high relative humidities are more dangerous than high temperatures because of the possibility of fungus growth. In localities where inside relative humidities of 60 percent or higher prevail, it may be advisable to build a moisture-proof box in which to store a film collection with silica gel. The box should be provided with a rubber gasket to make a tight-closing lid, and the films should be arranged to permit adequate circulation of air within the box.

To prevent physical damage, film should never be touched with the fingers except at the edges. Sheet and roll-film originals should be kept in the transparent sleeves designed for storage purposes. If much handling is required, it might be wise to make duplicate negatives and keep the original master on file.

Exercises (625):

1. What are three conditions that are likely to cause damage to film?

2. Film should be stored at what relative humidity levels?

3. High relative humidity can cause what kind of film problem?

4. What should be done if there must be extensive handling of a particular sheet of film?

2-4. Operator Maintenance

626. Complete a series of statements about operator maintenance of film processing and finishing facilities.

Many of the tasks you perform in processing and finishing film are tasks that maintain the serviceability of the equipment and facilities.

When you first start to work in a particular section of a lab, take a look around you and familiarize yourself with the total layout of your work environment. No two laboratories are exactly alike because this depends on their mission and the types of end products required. However, certain things are common to all processing darkrooms. Every darkroom should have a dry side and a wet side. The wet side is the processing sink and the chemistry involved. The dry side is a work surface where unexposed film is loaded into film holders and cassettes and exposed film is down loaded and prepared for processing.

A big part of operator maintenance is cleanliness. Leave the processing room in the condition that you find it. That is, it should be clean and all equipment that you used should be returned to its proper storage place.

A typical film processing room will have shelves or wall racks at the back or above the work surface for storage of film hangers and reels. When selecting the required number of reels or hangers that you will need to process a batch of film, inspect each of them for damage that could give you difficulty in loading in the dark. A bent film reel is almost impossible to load and a film hanger with a missing retainer clip could cause film to fall out during processing. Set bent or broken items aside and turn them into your supervisor or maintenance personnel. A bent reel can sometimes be straightened but usually needs replacement. An advantage to storing reels and hangers out of the way is that they are less susceptible to being damaged.

Another part of processing that is considered maintenance, is the proper use of control charts and logs. Many labs do not replenish their solutions because of low usage.

Instead, they use a chart which adds development time to the process for each succeeding batch of film processed. The amount of time to be increased depends on the square footage of film previously processed. You are responsible for adding up the total square footage of film you are processing and adding it to the chart.

Also, don't forget to fill out your part of the work request on film processing.

Now let's go over to the wet side of the processing room and talk about what must be done.

Each deep tank has a floating lid which prevents oxidation of chemicals while they are not in use. Replace these lids after processing. The process thermometer should be rinsed in water after checking solution temperature and returned to a secure place. Roll film tanks, reels, and processing hangers must be rinsed in running water after processing. Allow them to air dry naturally or a quicker method is to place them in the bottom of the film dryer and let them dry along with the film. Hand drying with cloth or paper towels should be avoided because they leave lint on the equipment.

While you are waiting for your film and reels to dry, wipe down the sink backsplash and the outside of any processing tanks with a damp sponge rinsed out often. Wipe down the work surface also.

Most labs make it a weekly practice to thoroughly vacuum the floors, work surfaces, and ledges that can gather dust. This is also the time for discarding used chemistry and refilling the tanks with fresh solutions. Be sure that you thoroughly clean each tank of any residue before refilling them. Refill each tank so that film hangers will be completely submerged when inserted into them.

A word of caution on stainless steel. Never use an abrasive, such as scouring powder or steel wool to clean stainless steel because it will rust. Most marks are easily removed by using warm water and a sponge. For stubborn marks use a non-abrasive cleaning pad.

The film dryer is easy to maintain. Wipe down the dryer interior with a damp sponge once a week. Check the air intake filter often and replace it when necessary. This filter is the same design as a furnace filter. It can be removed by lifting the loose panel which serves as the floor to the dryer interior.

Exercises (626):

1. What is the purpose of floating lids for processing tanks?

2. How should processing reels be cleaned?

3. What should be used to clean stainless steel equipment?

4. Where is the air filter for film drying cabinet located?

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CHAPTER 3

Black-and-White Printing

THE FINAL OUTCOME of your work will be a print. So far we have covered exposure, composition, camera assignments, and a multitude of photographic woes. Now it is time to make the final print. If you will pardon our boldness, let us say that the proof is in the printing.

3-1. Preparing To Print

627. State the principles underlying specific darkroom procedures and equipment for printing.

The location of the darkrooms depend on the available space and the type and amount of work to be accomplished. However, it is obvious that even a small room that is well arranged is an aid to production, whereas a rambling place that is too large is time-consuming. Furthermore, there is less waste, the work is less tiring, and personnel are less likely to have accidents when a standardized procedure is set up and closely followed. Hence, the exposing, developing, rinsing, fixing, and washing of prints may proceed from left to right, or vice versa, but a definite routine should be established.

Darkrooms should be provided with adequate fresh air, and the stale and noxious air should be withdrawn by power blowers installed in the walls. It is also important to maintain darkroom temperature around 70° F (21° C.). This temperature not only provides a comfortable environment to work in but also is a great aid in keeping the solution temperatures at the right level.

The sinks should be centrally located to save unnecessary steps and time. They should be large enough to hold the largest trays. Tray racks may be placed over the sinks so that any liquid that may splash or spill out runs into the sink and is disposed of through the drain.

Hot and cold running water is absolutely essential. There should be a number of convenient outlets. In addition, there should be a water mixing valve for controlling the temperature.

Darkroom Equipment. The carefully planned printing room should contain the following materials and equipment properly arranged so that the flow of work moves easily from one stage to another: a contact printer or projection printer (or both, etc.), an easel, safelights, a sink and trays for the solutions, graduates for measuring and mixing solutions, a thermometer, towels, at least two pairs of print tongs, an interval timer, and a wall clock with a sweep-second hand. (This list is *not* exhaustive. There should also be suitable multiples of this equipment, depending on the number of workers in the lab.)

Trays. There should be five trays arranged in the sink so that prints can be processed in orderly progression from developer, stop bath, first fixer, second fixer, and water tray. The water tray can hold the prints until they can be placed in the mechanical washer. The trays should be a minimum of 11 x 14 inches (28 x 36 cm) for convenient use in processing 8 x 10 prints.

Timers. Most printing rooms contain two types of timers: a large clock with a sweep-second hand and interval timers connected to the contact and projection printers.

The clock timer most often has a black background with a luminous dial (Gra-Lab type, etc.). The dial has a 1-second graduation and a large sweep-second hand. It is normally located on a shelf over the developing tray. It should be used to time each step of the process. (Make sure that the clock is properly maintained. Through use and abuse, the clock can become inaccurate or cease to have a smooth sweep-second hand.)

There are a number of models of interval timers used to time the exposure when printing. Some are built into the printer and others are connected electrically. However, all work on the same principle. The exposure time is set by moving a pointer to the desired time on the dial; the exposure button is pressed and the printing paper is exposed for the given time. When making a number of prints from one negative, this precise timing of exposure will insure greater uniformity of results. A FOCUS button is also provided on the timer to permit the operator to have the printing light on continuously to view the image for focusing and composition.

NOTE: Remember that good laboratory safety requires that all electrical equipment be properly grounded. Many a technician has received quite a shock by simultaneously touching a printer and interval timer when they were not properly grounded.

Print tongs. Most technicians like to use print tongs to handle the print during processing. This technique eliminates the need to handle the print with possible hypo-stained hands that can cause those unsightly white fingerprint marks and require the print to be done over. If you use tongs, keep two points in mind: (1) keep the tongs clean and (2) use two pair of tongs—one pair to handle the print in the developer and carry it to the stop bath and the other pair to handle the print through the remaining steps (the use of two pair of tongs is necessary to prevent contamination).

Laboratory Cleanliness. In most photographic publications, there is a section on defects. A close study shows that many defects are caused by a lack of cleanliness in the laboratory. It is much easier and cheaper to maintain a clean laboratory than to spend time, effort, and materials to correct defects (i.e., spotting prints or reprinting).

Remember to establish a wet side for the solutions and a dry side for the printers. You must keep the dry side dry and free from contaminants. This carefulness insures much cleaner prints.

After processing operations, your hands are wet with water or chemical solutions. In either case, rinse them in clean water and dry them on a clean towel—not one contaminated with chemicals. Be sure that your hands are dry before your return to the dry side.

Avoid splashing chemicals. Splashing chemicals on the floor or your clothing transfers them to the dry side, where they may ruin the prints. Chemicals splashed on the floor may go unnoticed until they dry to a powder. Walking back and forth agitates the powdery crystals and they become airborne. Ultimately these particles settle on your negatives and paper, causing spots that require retouching on negatives and spotting on the prints. Remember, therefore, to clean up all spills as soon as possible.

Regular cleaning of the laboratory is essential to quality production. No area should be overlooked. Floors should be mopped with a dust mop rather than a broom. Then use a wet mop to rinse the floor with clean water. Never use a dirty mop, as this only moves the dirt from one place to another.

When a liquid is used to complete a cleaning job, remember that plain water will remove most chemical deposits. If a solvent is necessary, use as little as possible while following all safety precautions connected with its use.

Cleaning as you go saves time and materials in the long run. No one wants to work in a filthy environment, and you certainly cannot produce a high-quality product under unclean conditions.

Exercises (627):

1. Why is it important to have a definite routine to your darkroom arrangement?

2. Why should the darkroom temperature be about 70° F. (21° C.)?

3. What are the two types of timers you need when printing? What is each type used for?

4. Why do you need two sets of print tongs?

5. Why is cleanliness so important?

3-2. Preparing and Using Specified Processing Solutions

The proper selection, preparation, and use of your developer is very important to your print quality. In this section, we shall discuss these aspects of the print developer. Then we shall cover similar aspects of stop baths and fixing baths, as well as time/temperature controls.

628. Identify appropriate developers for print processing and explain procedures used in the preparation of a print developer.

Selecting the Print Developer. There are a number of print developers that are available. The developers vary in the tones and contrast they produce and the type of paper for which they are designed. Normally, each manufacturer recommends a particular developer(s) to match each type of paper. In selecting your developer, you must carefully consider the type of paper you are using and the result that you want. Following is a list of Kodak paper developers, their recommended dilution ratios, their processing times, and their purposes. This list is to just give you an idea that several paper developers exist. Other manufacturers would produce a similar list. The basic paper developer in the Air Force is the D-72 (used 1:2 for 2 minutes), which is equivalent to Kodak's Dektol.

Kodak Developer and Dilution Ratio	*Recommended Range of Development Time in Seconds	Use
Dektol (1:2)	45 to 180	Yields neutral and cold tones on cold-tone paper (e.g., Kodabromide).
Selectol (1:1)	90 to 240	Is suitable for warm-tone paper and warmer tones on other paper (e.g., Polylure).
Selectol Soft (1:1)	90 to 240	Is a companion to Selectol but gives lower contrast.
Ektonal (1:1)	90 to 240	Is specially designed for warm-tone papers that are to be toned (e.g., Opal).

*The exact processing time depends on the paper being used and the temperature of the solution.

Preparing Print Developers. Once you have selected the developer you want to use, it should be properly prepared for use. The following points should be considered in making your stock solution. (Once you have prepared your stock solution, you then can prepare your working solution. The working solution is the stock solution diluted, if required, to its processing strength.)

a. Safety. Throughout the preparation (and use) of the developer (or any other solution), remember chemical safety. Chemical mixing should take place in a well-ventilated room. Always remember to add the chemicals to water. Do not swallow the chemicals or get them in your eyes. It is a good idea to wear rubber gloves and a face mask to eliminate chemical hazards.

b. Following directions. One of the most important requirements for mixing the developer is to follow the manufacturer's instructions. Failure to follow directions results in solutions that do not perform consistently and properly. This wastes materials.

c. Water supply. Impurities in the water can cause stains. Use filters to remove impurities from the water. Where very critical work is being done, distilled water may be required.

d. Mixing container. The mixing container and the stirring rod that are used must be clean and of the right kind of material to prevent contamination or chemical reactions. Stainless-steel, rubber, polyethylene, glass, and enameled steel are materials commonly used in chemical mixing equipment.

e. Temperature and sequence. To stress the point again, follow the manufacturer's directions regarding water temperature (which may be higher for mixing than for use) and the exact sequence that components are to be mixed.

f. Agitation. Proper agitation (stirring) during mixing is most important to insure that the chemicals are properly dissolved in the water. It is a good idea to introduce only small quantities of the chemical at a time while stirring smoothly but vigorously. (Do not stir so vigorously as to cause the introduction of air into the solution or splashing of the solution.)

g. Storing. Proper storage is essential to preserve the solution. The developer can be stored in a stoppered amber bottle or an opaque plastic container with a top or floating lid.

Exercises (628):

1. Which of the following developers are used in print processing?
   a. D-19.
   b. Dektol.
   c. D-76.
   d. DK.
   e. D-72.
   f. Metolflow.
   g. Selectol.

2. What should be your two main considerations when you are choosing a mixing container?

3. What is probably the most important rule in the preparation of a developer?

4. What type of protection should you wear when mixing chemicals?

5. Too vigorous stirring when you are mixing the developer can cause what problems?

629. Briefly explain steps to follow when you are developing a print.

Using Print Developers. Once the stock solution has been prepared, you can make the working solution. The working solution is prepared by mixing the stock solution with the proper amount of water. The working solution then can be poured into the developer tray for processing.

Once your darkroom is all set up, all solutions are at the right temperature, and you have exposed your first sheet, you should follow these steps to develop your print:

(1) Set your wall timer for the processing time. The clock should start once the paper is in the tray. (Some technicians have the clock run all the time and then

start processing on any suitable whole minute. This procedure saves resetting the clock or having to start and stop it all the time.)

(2) Place the print into the developer tray. You may find one of the following two ways to be easier for you. First, simply slide the paper into the tray. The other method is to lay the paper emulsion down into the developer, then press it completely under the solution. The important thing is that you get the print wet quickly and evenly. Air bubbles and developer splashes will cause circles on the print.

(3) Agitate the print constantly throughout the developing time. This does not have to be violent, only continuous movement is necessary.

(4) For an accurate 2-minute development (or other times as recommended), lift the paper after 1 minute and 50 seconds of development (i.e., 10 seconds before the end of the development time). Drain the paper for 10 seconds and then slide it into the stop bath. (Accurate timing of your processing is important in order to determine proper exposure. Process by the clock and not by your eyes, as the density of the print under the safelights and in the developer is deceptive.)

A slightly different procedure is used if you are developing more than one sheet of paper at one time. If this is the case, first, put one sheet at a time, emulsion side down, in the developer. Then proceed to agitate by pulling the first (bottom) sheet out from under and putting it face up on top of the stack of prints. Immediately follow it with the next sheet from the bottom and continue until the whole pile is face up. At once, pull them through again, one by one in the same order, to make a face down pile; continue to flip through the prints this way, carefully and regularly, until the end of the development time. Drain each print prior to putting it in the stop bath. NOTE: To insure consistent timing, it is important to count as you go so that the *first print in* is the *first print out*.

Exercises (629):

1. Print processing normally calls for what type of agitation? Why?

2. How do you place a single sheet of paper into the developer?

3. What procedure should you follow to insure an accurate processing time?

4. How should you agitate prints when you have to process more than one print at a time?

638. Indicate characteristics of stop baths and fixing baths and explain how to prepare and use these solutions.

Once you have developed your print, you need to rinse it in a stop bath and then make the image permanent through use of a fixing bath.

Purpose of the Stop Bath. A stop bath, though it does not make the image permanent, serves two important purposes: (1) it stops or slows down development by neutralizing (a chemical reaction) or diluting the developer, and (2) it helps to prolong the strength of the fixing bath.

Preparing and Using the Stop Bath. There are basically two types of stop baths that are commonly used. These are water and acid. Plain water is used because it is readily available. However, it acts only as a rinse. It dilutes the developer, but it does not neutralize it (i.e., no chemical reactions are taking place).

If you use only water, make sure that you have the water continuously running into the tray to keep it fresh.

Most labs use an acid stop bath because the acid reacts with the alkaline in the developer and neutralizes it. To make an acid stop bath, first make a 28-percent solution of acetic acid from glacial acetic acid with eight parts water. To make the stop bath itself, add 1½ ounces (44.4ml) of the 28-percent acetic acid to 32 ounces (946.3ml) of water. (NOTE: Remember for safety's sake, *always add acid* (AAA rule) *to the water*.)

During use, the temperature of the stop bath should be the same as the other solutions. After development, place the print in the stop bath and be sure to agitate it for 15 to 30 seconds (longer if more than one print is treated at one time). Stains may result if prints are merely left to stand in the solution.

For best results, read the instructions that come with the paper that you are using. The instructions outline the type of stop bath to use and the time the print should remain in the bath.

Purpose of the Fixing Bath. The fixing bath is important because it chemically changes undeveloped silver (exposed or unexposed halides) into soluble salts that can be washed away. If undeveloped silver halides were to remain in the paper, they would discolor when exposed to light to which they were sensitive. This discoloration would result in fading of the image.

Preparing and Using the Fixing Bath. There are two types of ~~hypo~~ solutions in common use: one with and the other without hardener. For average use, the packaged ~~hypo~~ fixer with hardener, mixed with water according to the manufacturer's directions, is advisable. The purpose of the hardener is to prevent excessive swelling or softening of the emulsion. It is particularly important when you are processing at high temperatures. If you want to give your prints a post-processing treatment, such as toning, you should make your own fixing bath without hardener. The Photo Lab Index gives you formulas for these fixing baths.

In preparing to use a fixing bath, take a stock solution of hypo as your working solution (no dilution necessary). Prepare a setup of two fresh fixing baths. (When the first bath is exhausted, usually after processing two hundred 8 x 10 prints per gallon, replace it with the second fixing bath. A fresh bath then replaces the second bath.) The exact amount of time in each bath varies with the particular fixing bath, its temperature, and the paper being processed; but normally it would be 3.5 minutes per bath. ([redacted] Resin-coated projection paper [redacted] can be fixed in 2 minutes.) The length of time in the bath is important because too much time can cause bleaching and too little won't do a permanent job. The temperature of the bath should be similar to the other solutions. Proper agitation is also very important; without it, uneven fixing may result.

A print can be examined under a white light after it has been properly fixed for 2 minutes.

Exercises (630):

1. Why is a stop bath an aid to accurate development times?

2. What is the main advantage of an acid stop bath over a water stop bath?

3. How long should a print stay in a stop bath?

4. What is the purpose of a hardening fixing bath?

5. What is the advantage of using resin-coated paper?

631. Explain how to control the relationship between development time and temperature in print processing.

Establishing Time/Temperature Controls. Just as in film processing, the factors of solution temperature and the length of time the sensitized material is in the solution are important factors in determining the quality of the result. If the paper is developed for too short a time or at too low a temperature, a weak, low-density, low-contrast print will result. Underdevelopment can result in a loss of detail in the highlight portion of the subject. On the other hand, if the print is developed for too long a period or at too high a temperature, the result will be a print with too much density with a slight increase in contrast. Extreme overdevelopment can lead to fogging.

The ideal procedure to control your processing time is to establish temperature control of all your solutions. By having all the solutions at the recommended 68° F. (20° C.), you can follow through with the recommended times. This control can be established by using a thermometer to check the temperatures and a water mixing valve to get the water for mixing the solutions to the right temperature.

If you cannot establish a temperature of 68° F. (20° C.) you must modify your processing times accordingly. Check the instructions that come with your paper or developer for a time/temperature chart that gives the appropriate time for the temperature you are using.

Exercises (631):

1. What is the relationship between time and temperature when you are processing a print?

2. How can you establish temperature control of your solutions?

632. Explain principles and procedures related to the agitation of prints during processing.

Agitation is very important in every step of print processing. We have mentioned it on a continuing basis throughout the chapter, but now we will explore it further to emphasize its importance in correct processing.

Purposes of Agitation. Agitation is important in every step in processing, but its importance can be comprehended best by understanding what takes place during development. During development, the solution reduces the exposed silver halide grains in the emulsion to metallic silver. In the process, a number of oxidation and chemical by-products are formed. These by-products will retard development if not replaced by fresh solution.

When you have stagnant development (no agitation), some portions of the solution are richer in byproducts than others, due to the fact that at regions of high exposure, more development takes place than at low exposure regions. For this reason too, development is retarded to a much greater extent at regions of high exposure than at those of low exposure. A lack of agitation also produces development mottle (streaks). This defect occurs because the diffusion of fresh developer and reaction byproducts from within the emulsion take the path of convection currents. In the unagitated solution, these currents take slow, random, irregular paths, producing uneven development.

This same effect can take place in the other solutions. Improper agitation in the fixing bath can lead to stains and uneven fixing that will result in fading as time goes on.

Air bells can also be eliminated by proper agitation. Air bells are tiny bubbles in the developing solution, which can cling tenaciously to the paper emulsion and cause small circular or elliptical clear spots to occur. A spot having soft edges or one of low density indicates that the bubble grew smaller as development progressed or broke before development was completed.

Methods of Tray Agitation. When processing a single print at a time, you can agitate each of the solutions by continuously rocking the tray. For the fixing bath, you should have continuous agitation for the first 2 minutes; you should then agitate at least once every minute after that.

When working with more than one print, you move the prints rather than the tray, leafing each print in rotation from bottom to top throughout the processing. It is important to count each print as you go, so that you can transfer the prints in order from one solution to another.

Exercises (632):

1. What is formed during processing, thereby making necessary a continuous replacement of fresh developer?

2. What is mottle? How is it caused?

3. What are air bells? How do they affect a print?

4. When processing a single print, you agitate by moving the ________ ; when processing groups of prints at one time, you agitate by moving the ________ .

3-3. Printing Papers

When you get ready to make a print, you will have to make some choices. Surface, texture, base, graded or variable contrast, and sensitivity of various photographic papers are all considerations for you to think about.

In our particular lab you may not have to make these decisions because someone has ordered only one or two types of paper. However, it will benefit your overall photo knowledge if you know some of the basic characteristics of photo printing papers.

633. Specify the characteristics of printing papers.

Black-and-white printing papers are available in many different varieties. We can classify them into a few basic types and classes, depending on their speed, contrast, and color of image. They are further broken down according to the type of base. That is, their weight, color, surface, and texture.

Your choice of printing paper speed should be based on the way you intend to use it. Slow, contact printing papers are usually silver chloride emulsions. Enlarging papers, which must be faster, usually have an emulsion of silver bromide and silver chloride. Some papers, called slow chlorobromide are used for printing portraits.

The type of emulsion not only affects the speed, it also affects the color of the image. Slow chloride emulsions give warm tones, sometimes they even go brown. Chlorobromide papers differ in tone according to the dominant halides. Some chlorobromide papers are warm toned and some of the faster chlorobromide papers produce colder, blacker tones. Generally speaking, we can say that warm-toned papers are slower then the cool-toned papers.

Contrast in printing papers is also controlled by the emulsion coating. Some papers, called graded contrast papers, are coated to produce a certain contrast or tonal range. To use them to achieve proper contrast, you must have a selection of each grade, usually 1 through 4. Graded paper number 2 is considered to be normal. The higher the grade of paper, the greater contrast it produces. Low contrast negatives would require grades 3 or 4, while high contrast negatives would be printed on contrast grade 1 paper.

Other contrast controlling papers are called variable contrast papers. With these you control the contrast by using colored filters between the paper and the light source. The manner in which the emulsion is made controls the contrast.

A portion of the silver halides in variable contrast printing paper are sensitive to yellowish light and produce lowered contrast when printing through the appropriate variable contrast printing filter. Other silver halides in the emulsion are only blue sensitive and produce higher contrast through the appropriate printing filter. Normal contrast is achieved by printing without a filter or using the preferred method of printing through the filter in the set that produces normal contrast. For Kodak polycontrast filters, use the number 2 filter. For a ten-filter set of variable contrast printing filters, use the number 5 filter for normal contrast.

One more characteristic of printing papers is the base material. Some papers are made with fiber-based paper. Others are made with a base that is coated with resin. The resin-coated (RC) papers do not soak up water and solutions like the fiber papers.

The greatest advantage of using RC papers is in the time and water savings during the washing cycles. The disadvantages of RC papers are their lack of permanence and their inability to produce jet-black tones like the fiber-based papers.

A special-purpose, panchromatic printing paper is needed when making black-and-white prints from color negatives. Kodak Panalure is an example of this type of paper.

The reason you need special paper is because of the color negative. A color negative contains dye images that transmit all of the colors to light. If you used normal black-and-white printing paper that is sensitive to blue and green, you would not get a satisfactory image of the red objects in the scene. Additionally, some color negatives have an overall orange cast that reduces contrast and exposure on normal papers.

Using the panchromatic type papers with color negatives will give you very pleasing results. You also get an additional advantage in local density control. With the panchromatic papers, you can change the density of an area by using filters during the exposure.

Exercise (633):

1. From the following statements select those that are true.
   a. Slow contact printing papers are made with silver bromide emulsions.
   b. Warm-toned papers are usually slower than cool-toned papers.
   c. Graded contrast paper number 4 should be used to print a flat negative.
   d. Variable contrast paper is made with blue and red sensitive silver halides.
   e. Resin-coated papers do not need to be washed as long as fiber base paper.
   f. Paper used to print color negatives is monochromatic.

634. Explain how to control paper contrast and identify the various grades of paper in terms of their contrast ranges.

Contrast of Graded Papers. The term "contrast" is used in the same manner for prints as it is for film. Contrast is the difference between the highlights and the shadows. A low-contrast print is dominated by gray tones, while a contrasty print is dominated by blacks and whites. A normal print should have a variety of tones ranging from white through black.

Since a print is viewed by reflected light, the emulsion must be thin so that only a minimum amount of the incident light falling upon it is absorbed. Hence, there is much less concentration of silver compounds in printing emulsions than in film emulsions. As a result, the emulsion of the photographic paper should be exposed normally and developed fully in order to obtain the best print possible.

Contrast, however, is not totally controlled by development. Instead, your choice of printing papers supplied with a variety of inherent contrasts, is the significant factor. It is not always possible to produce negatives that are exactly normal in contrast. Consequently, variations in printing materials are made to compensate for those negatives that are not normal and to produce the best possible print. These materials are made with several different types of emulsions and each type is adaptable to a negative of a certain contrast. All of these emulsions are designed to record approximately the full range of tones in the negative and yet maintain a pleasing tonal contrast.

Contrast Grades. Most papers are made in several contrast grades. This range of contrast is essential for the photographer, who wants to produce the best possible print from any type of negative—that is, from soft (low contrast) to hard (high contrast). Each manufacturer of printing paper has classified the range of contrasts according to its standards. Therefore, the contrast of a particular grade number and description may not agree with that of another carrying the same identifier. (Paper from the same manufacturer may also vary from one emulsion batch to another and performance may also change with age.) Papers that are currently available conform, in a broad sense, to the following scale:

* No. 0	Extra soft—Normal prints from very contrasty negatives; very flat prints from normal and soft negatives; designed for contact printing
No. 1	Soft—Normal prints from contrasty negatives; flat prints from normal and soft negatives.
No. 2	Normal—Normal prints from normal negatives; soft prints from low-contrast negatives, contrasty prints from contrasty negatives.
No. 3	Moderately high contrast—Normal prints from slightly soft negatives; contrasty prints from normal negatives.
No. 4	High contrast—Normal prints from low-contrast negatives; contrasty prints from normal negatives.
* No. 5	Very high contrast—Normal prints from very soft negatives; very contrasty prints from normal negatives.
* No. 6	Extremely high contrast—Normal prints from extremely flat negatives; ultra-high-contrast prints from normal and contrasty negatives.

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*Grades 0, 5, and 6 are not normally available through regular military supply channels.

Control of Contrast. The degree of contrast control that can be exercised during printing by exposure/development combinations is very small. (An exception is monocontrast portrait papers that are very sensitive to differences in processing.) Consequently, it is most important to use the correct grade of paper as the contrast control. The wide range of contrasts available is difficult to appreciate without studying actual comparison prints. Hence, during your training, you should produce a series of prints from a normal negative, each one on a different grade of paper. Your tests then can be extended to negatives having a variety of contrasts. These tests will show you the effect of increasing or decreasing original negative contrast during printing by the selection of the appropriate paper grade. By this experience, you will gain an understanding of what you can achieve when given a particular negative to print.

Exercises (634):

1. State the contrast produced by each of the following paper grades: 1, 3, and 5.
2. What contrast ~~guide~~ grade gives you normal contrast from a normal print?
3. What is the best way to control contrast in prints?

635. Describe the color sensitivity of variable-contrast paper in terms of specific colors and control method.

Instead of stocking a number of different contrast grades, many Air Force photo labs today prefer to use variable contrast papers. These papers have one emulsion made up of halides having different inherent contrasts that can be controlled. In this section, we shall discuss the characteristics of this type of paper.

Variable-Emulsion Sensitivity. A variable-contrast paper emulsion consists of combinations of halides that are sensitive to either yellow-green light or blue-violet light. The yellow-green sensitive halides control low contrast, while the blue-violet ones control high contrast. The particular degree of contrast is obtained by inserting an appropriate filter between the printing light source and the paper. The filter controls the color of light that reaches the printing paper, thereby controlling contrast.

By using only one type of paper and a set of filters, you can produce finer gradations of contrast than is possible with graded papers. Additionally, you can control contrast of localized sections of the printed image. This can be done by dodging (holding back the light from) all but a particular part of the print when the appropirate filter is in place. Then proceed to dodge the just printed portion when another filter is being used. For example, the low-contrast portion of an image could be improved by printing with blue-violet light, while the harsh part could be softened by printing with yellow-green light.

Exercises (635):

1. Halides in variable-contrast paper are sensitive to what colors of light?
2. What tool is used to control the color of light exposing the variable-contrast paper?

636. Indicate the appropriate printing filter to achieve a desired print contrast, and specify Kodak and wratten filter characteristics.

Variable-contrast emulsions are so designed that within a single emulsion you have available varying degrees of inherent contrast. This inherent contrast is controlled by the color of light used to expose the print material. The color of light is, in turn, controlled by the use of filters.

Printing Filters. Each photographic paper manufacturer produces different types of variable-contrast papers and an appropriate set of filters. For example, Kodak manufactures five variable-contrast papers—Polycontrast, Polycontrast rapid, Polycontrast rapid RC (resin-coated), Ektamatic SC, and Portralure (these papers vary in tone, speed, and surfaces, etc.)—and seven filters. The seven filters are numbered from 1 through 4 in increments of 1/2 and progressively change in color from a light yellow (1) to a dark magenta (4). Yellow filters are used to produce low contrast because they absorb blue light and transmit green (and red). The magenta filters produce high contrast because they absorb green and transmit blue (and red). (The paper is not sensitive to red.) Using a number 2 filter or not using any filter will produce normal contrast. Filters are usually made out of plastic or acetate and can be used in contact or projection printing.

After you have selected a suitable variable-contrast paper (for example, Polycontrast) for your printing, you must evaluate the contrast of your negative. A high-contrast negative may require the use of a low-contrast filter, while a low-contrast negative may require a high-contrast filter. If the negative is normal, you can use either a number 2 filter or no filter at all. For example, if your negative were slightly low-contrast, you would choose a number 3 filter. (If you treat the Kodak filter numbers as "paper grades," you will have no trouble in choosing the appropriate filter. Other filter sets may require different selection standards.)

In terms of safelights, the Wratten 0A filter (yellow-green), which is "safe" for graded-contrast paper, cannot be used with variable-contrast paper. Since the paper is sensitive to green, using the 0A safelight would fog it. The safelight filters recommended for variable-contrast papers are the DuPont S-55X (orange-brown) or the Wratten 0C (amber).

Printing filters should be treated with the same care as filters used over a camera lens. A dirty, scratched, or faded printing filter will degrade the printed image.

Exercises (636):

1. Which Kodak printing filter should you use to achieve normal contrast when given each one of the following types of negatives?
   a. Normal negative.
   b. Very-low-contrast negative.
   c. High-contrast negative.
2. What is the range of Kodak filters for variable-contrast papers?
3. Why should you avoid using a safelight with a Wratten 0A filter when producing prints on variable-contrast paper?

637. Define the term "paper surface" and briefly explain why surface selection is important in producing prints.

The final effect of a print depends to a great degree upon the surface of the paper on which it is printed. For this reason, papers are manufactured with a wide variety of surfaces, thus permitting the selection of a surface that contributes the most to the purpose for which the print is intended. In this section we shall cover a few basic surface types you can choose from. The information can be applied to both variable-contrast and graded papers.

The wide variety of paper surfaces available makes possible the careful selection of a surface that contributes to the overall visual effect of a print. The surface characteristics of a paper are no less important than tint or tone in producing a print that accurately portrays the subject. (When we speak of tint, we are referring to the range of colors of the print paper stock. The tint may range from a white to a cream, etc. Image tone refers to the developed image color, which may run from blue-black to brown, etc.) The term "surface" refers to the finish and texture of the paper.

The paper's surface influences the amount of light that is reflected from the print. Textures are generally identified as smooth, fine-grained, or rough. There are also specialized surfaces that resemble silk or suede. Many of these special surfaced papers can be ordered from the Federal Supply Catalog, Class 6750. (Paper manufacturers provide paper samplers so that you can see the effect of their different types of papers.) Finish, or brilliance, refers to the shininess of the print, as distinguished from its texture. For example, smooth-textured papers are made in both glossy and matte finishes.

An extremely smooth surface, with regard to both finish and texture, looks bright because it reflects most of the light falling on it. The maximum detail is therefore revealed. A dull textured surface, as is found with matte and some semimatte papers, scatters the light and obscures detail. This scattering not only dims the highlights but also makes the black or dark portions of a print look grayish. However, such an effect is less harsh and may add a mood to a picture in which detail is not critical as in scenics or portraiture.

Exercises (637):

1. What is a paper's "surface"?
2. Why is it important to match the paper's surface with the image?

638. Distinguish between different types of paper surfaces.

You will develop taste and judgment in the selection of the appropriate paper through experience. You should start by studying paper samplers put out by the leading manufacturers. After you have an idea of what is available, follow up by printing a suitable negative on a couple of different surfaces to see the effect that each surface has on the resulting print.

The more common finishes are glossy, high luster, luster, semimatte, and matte. We shall limit our discussion here to glossy, semimatte, and matte.

Glossy. The sheen of a particular surface is dependent upon how it reflects the light striking it. Practically all of the light is reflected from a glossy surface. This great amount of reflected light gives maximum detail and brilliance, which are required in many Air Force photographs. A very high gloss, needed for pictures to be reproduced in a base newspaper or other publications (such as this CDC), can be obtained by placing a wet glossy print face down onto a chrome sheet and allowing it to dry. However, to achieve the maximum gloss that the paper surface will produce, you must follow the manufacturer's directions. For example, certain papers must be ferrotyped (dried with the emulsion in contact with highly polished surface), while the new resin-coated papers will air dry to a high gloss.

Semimatte. Semimatte papers have a smooth surface with little texturing. This type of paper dries to a semigloss or flat finish. Semimatte papers are suitable for portrait work and other subjects where maximum detail and contrast are not required.

Matte. The reflected light from matte surfaces is almost completely diffused. These softer, less glaring surfaces are preferred by most photographers for pictorials, portraits, landscapes, and other views not requiring a great deal of detail and brilliance. The smooth paper bases have no pattern. The rougher bases have a noticeable texture that may vary from a slightly pebbled effect to a fabric-like texture resembling linen or a very rough tweed. Smooth papers are recommended for small prints that require good definition and detail rendition. The rougher surfaces subdue fine detail in proportion to the degree of roughness and are useful for prints that do not depend upon detail for interest.

Exercises (638):

Match each description in column A with the appropriate paper surface listed in column B.

Column A	*Column B*
_____ 1. Has greatest variety of surfaces.	a. Glossy.
_____ 2. Gives maximum brilliance.	b. Semimatte.
_____ 3. Has semigloss or flat finish.	c. Matte.
_____ 4. Is used for pictures to be reproduced in publications.	
_____ 5. Is suitable for a nonglaring landscape in which detail is to be subdued.	
_____ 6. Has a smooth surface with little texturing and is suitable for portrait work.	
_____ 7. Gives maximum detail.	

639. Define "tone" and "contrast" and specify factors used to determine and control them.

Deciding on the appropriate tone and contrast of a print requires experience and judgment, since there is a variety of techniques and materials that are available. In this section we shall discuss a few points to help guide you in this area.

Tone. The tone of the print primarily depends on the paper/developer combination that is chosen. Many papers are cold toned and tones tend toward blue-blacks. Other papers are warm, and render brown tones. To achieve the appropriate tone, it is important to follow the paper manufacturer's recommendations for developer type and processing procedures. Another factor is correct exposure. Insufficient exposure renders the tones too light; too much exposure renders them too dark. (NOTE: As a print finishing technique, chemical toning can be done after the print has been processed in order to produce overall tints of many different colors.)

Contrast. Contrast is the difference between the highlights and the shadows. Your final print contrast depends primarily on the inherent contrast of the negative, the grade of paper or the filter and variable-contrast paper you have chosen, and the developer. Combining short exposure with longer development to produce high contrast or long exposure and short development to produce flatter prints is possible to a limited degree but is not generally recommended.

Tips on Controlling Tone and Contrast. Consider the following points when deciding how the tone and contrast of your prints should be.

a. Try to duplicate the tone and contrast of the original subject. If the values of the print reproduce those of the original subject, your print is likely to have the proper contrast. How much printing manipulation is necessary depends to a great degree on the negative. If the negative does not reproduce the contrast of the original scene, it takes careful selection of paper, developer, exposure and contrast control techniques (grade of paper, dodging, burning-in, etc.) to obtain the necessary results.

b. Preserve detail in both the shadows and highlights. This preservation of detail is particularly important in Air Force photography because the final product is often needed primarily to provide a detailed rendering of the subject. If the negative is very contrasty, it may take a low-contrast paper, along with some burning-in, in order to get the detail. Of course, if there is no detail in the negative to begin with, there is no way to put it in the print.

c. The picture must fulfill the mission requirements. The use of the final product is the key to deciding what to do. Is the print for the base newspaper where reproduction requirements may call for a less contrasting print? Is it for display on a wall where the impact on the people passing by is very important? (In such a case, you must consider the lighting in the room, the color of the walls, other pictures or decor, etc.) Is it being used in an accident investigation where maximum detail is vital? The variety of uses for the resulting print necessitates your learning a number of techniques and being knowledgeable about all the materials in your lab's supply. Know what you can do with what you have.

Exercises (639):

1. Define print tone.

2. Define print contrast.

3. Describe how the print is controlled by the choice of materials and techniques that are used.

4. List three important factors in controlling print contrast.

5. Why must you consider mission requirements as you carry out your printing work?

640. Given a series of printing situations, choose the appropriate printing filter to achieve the required contrast and state proper procedures related to the use of variable-contrast filters.

Using Variable-Contrast Printing Filters. To meet their printing requirements, the majority of base photo laboratories are standardizing on variable-contrast paper rather than graded paper. To control contrast with this type of paper, you must use variable-contrast filters.

As we mentioned when we were discussing print materials, variable-contrast papers have orthochromatic sensitivity. The blue-sensitive part of the emulsion controls high contrast, and the green-sensitive part controls low contrast. By interposing the appropriate variable-contrast filter between the light source and the paper, the contrast can be controlled. Depending on the paper's manufacturer, there are sets of filters running from yellow (for low contrast) through dark magenta (for high contrast).

When making your test strips to determine correct exposure, you need to also determine the contrast. You do this by examining the shadow area of a test strip that has the correct highlight exposure. If the shadow area of this test is too light, the paper does not have sufficient contrast. If the paper has insufficient contrast, a higher-numbered filter is needed. If the shadow area is too dark, the paper has too much inherent contrast and a lower-numbered filter is needed.

Earlier we presented a basic guide in determining the proper graded paper to use to achieve a desired amount of contrast. Now let us examine a similar basic guide in determining the correct filter to use. (The guide below is based on using a 1, 2, 3, or 4 Polycontrast (Kodak) filter. The principles would apply to other makes of filters and to the application of intermediate values such as 1½, 2½, or 3½, etc.)

Filter	Results
No. 1	Soft—Normal prints from contrasty negatives; flat prints from normal and soft negatives.
No. 2	Normal—Normal prints from normal negatives; soft prints from low-contrast negatives; contrasty prints from contrasty negatives.
No. 3	Moderately high contrast—Normal prints from slightly soft negatives; contrasty prints from normal negatives.
No. 4	High contrast—Normal prints from low-contrast negatives; contrasty prints from normal negatives.

Figures 3-1A and 3-1B show a series of prints produced by using the above filters.

When using variable-contrast filters, you should remember the following:

a. The filters are available in acetate rolls for contact printing or as individual filters for projection printing.

b. When in use, the filters should be clean and in good order (not scratched). Like all filters, eventually the printing filters will fade and have to be replaced.

c. When being used, the filter should lie flat to insure even exposure over the entire print.

d. The densities of the filters are indicated by the different numbers. For example, a No. 4 filter is darker than a number 3. This being the case, when printing with a No. 4, your exposure times need to be relatively longer. It is a good idea, therefore, to make additional test strips when you change filters.

e. Some contact printers commonly used by the Air Force are equipped with argon exposing lamps. Since these lamps are very rich in blue and ultraviolet (and very limited in the green and red spectrum), they cannot be used for printing variable-contrast paper. It is possible to modify such a printer by installing white incandescent lamps.

f. As we have previously discussed, dodging and burning-in can be effective in controlling local density. It is also possible to change filters to control local contrast. For example, it might be better to give the print an overall exposure with a number 2 filter and then burn in the sky with the aid of a number 3 filter. It is a good idea to work from a full test print to determine the best approach.

g. Study the manufacturer's directions that come with the paper so that you can use their filter paper combination to best effect. (As we indicated early in this volume, too many of us are guilty of throwing away the manufacturer's directions that come with our photo materials. By keeping them in a reference book, we could have a tremendous source of information that would save our time and materials.)

Exercises (640):

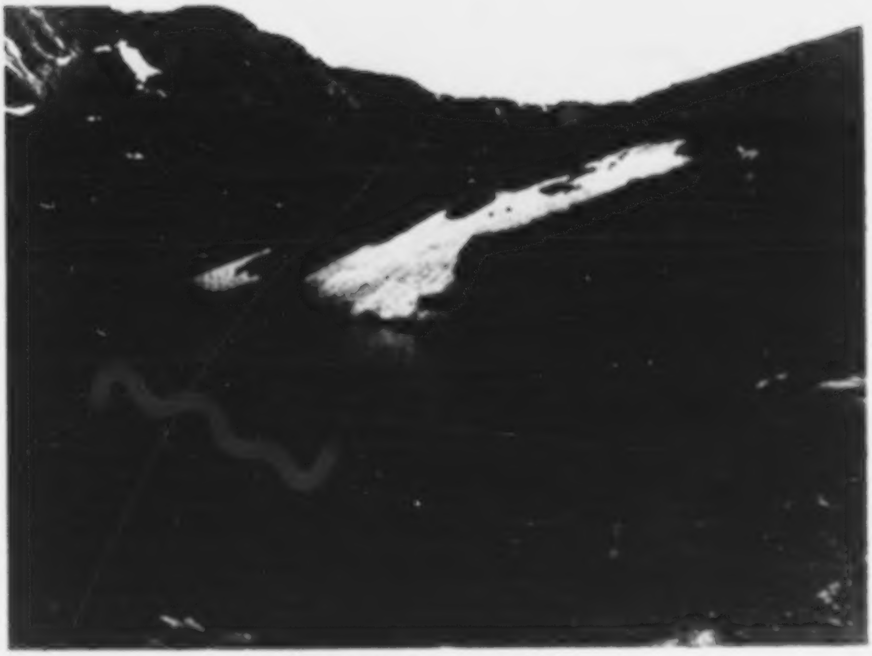
1. Determine the correct Polycontrast filter (1, 2, 3, or 4) to be used in the following printing situations.
   a. You have been given a soft negative that must be printed to a high contrast.
   b. A contrasty negative must be printed to normal contrast.
   c. A normal negative must be printed to very high contrast.
   d. A low-contrast negative must be printed to normal contrast.
   e. A low-contrast negative must be printed to low contrast.

2. What type of variable-contrast filters are used in ~~contrast~~ printing?

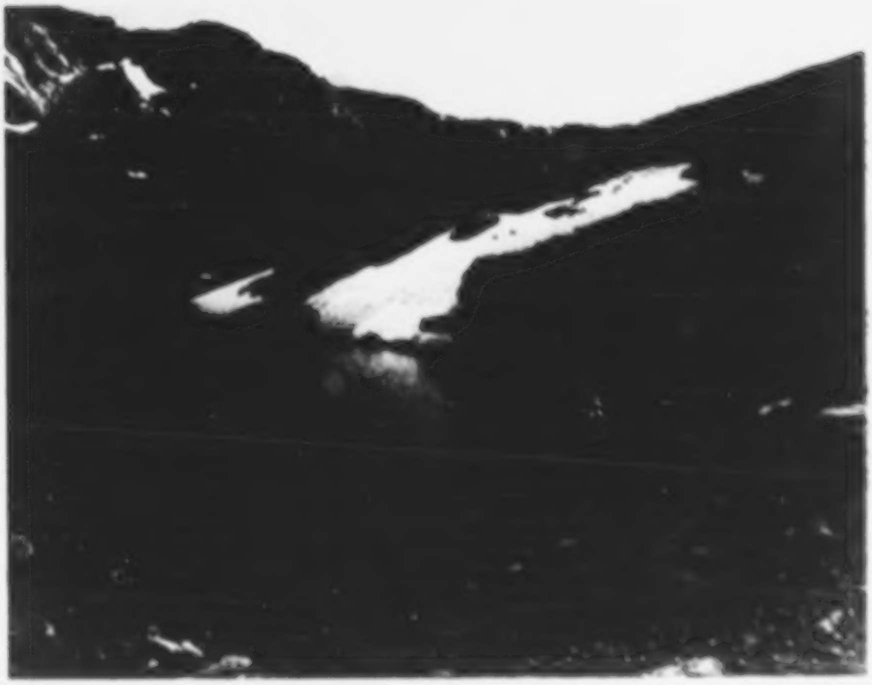
Contact

3. How should filters be maintained for printing?

4. What can't you use argon lighting in variable-contrast printing?



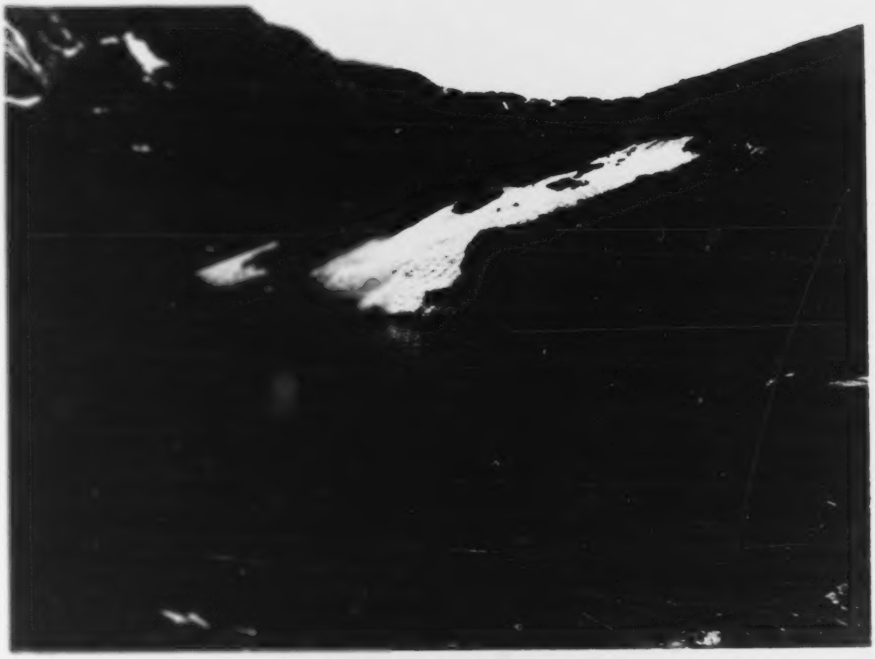
POLYCONTRAST FILTER 1



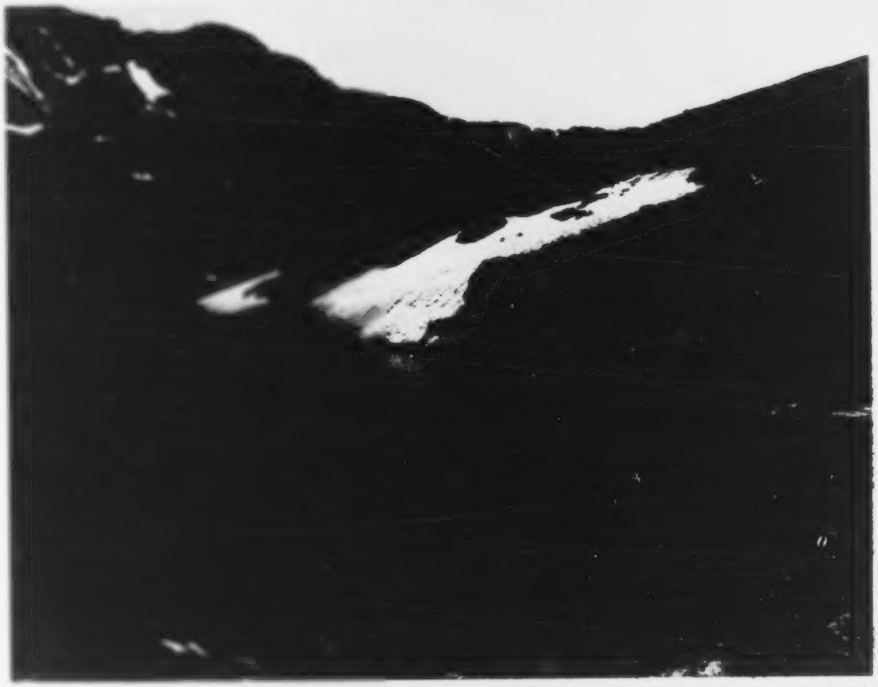
POLYCONTRAST FILTER 2

231-276C

Figure 3-14. Use of variable contrast printing filters.



POLYCONTRAST FILTER 3



POLYCONTRAST FILTER 4

231-276D

Figure 3-18. Use of variable contrast printing filters.

3-4. Contact Printing

A portion of your printing requirements can be satisfied by contact printing. Usually, when making a print the same size as the negative, you use a contact printer. Contact printers are ideal for making transparencies and proof sheets (a proof sheet is a print of all of the images on a roll of film). The EN-22A contact printer covered in this section is a manually operated type that you are likely to be using.

641. Describe a manual contact printer in terms of operational requirements and characteristics.

Contact Printers. Most manual contact printers used by the Air Force are quite elaborate in their design. Some have a pneumatic (air-filled) bag platen, and others use a vacuum platen to insure contact between the negative and the sensitized material. In some printers, a hand-operated switch automatically turns on the exposing lights when the platen is brought into position and locked.

The lamps in contact printers are usually high-actinic argon lamps for graded papers and incandescent lamps for variable-contrast papers. Depending on design, you may find well over 176 lamps in a single printer. Normally, each lamp is connected to an individual switch so that various lamps, or lamp combinations, can be turned on or off at will. In addition to the exposing lights, contact printers are equipped with safelights and white (viewing) lights.

Automatic timers are even built into some printers. These timers can be set to give any desired exposure, from a fraction of a second up to several minutes. Most printers are equipped with sheets of diffusing glass located between the lights and the negative. These sheets contribute to an evenly diffused illumination over the entire surface of the negative when all lights are turned on.

Photographic Contact Printer, EN-22A. The EN-22A, shown in figure 3-2, is a self-contained printer that accommodates negatives up to 10 x 20 inches (25 x 50cm) and aerial roll film, supported by brackets, up to 9.5 inches (23cm) in width and 500 feet (152m) in length. It has 73 3-watt incandescent printing lights. ~~Each light can be watt incandescent printing lights~~. Each light can be individually controlled, and there are pattern switches that control groups of lights. This exact control of lighting permits dodging and burning-in of the image. There is also a built-in filter roll for variable-contrast paper. At each end of the filter roll, there is a section of clear acetate which is used for printing without a filter.

A sheet of diffusion glass is located directly above the lamps gives diffused, even illumination. Above the diffusion glass is a thick sheet of plate glass on which the negative is placed. ~~Additionally,~~ Three ~~other~~ different types of printing ~~gales~~ glass are provided. These are:

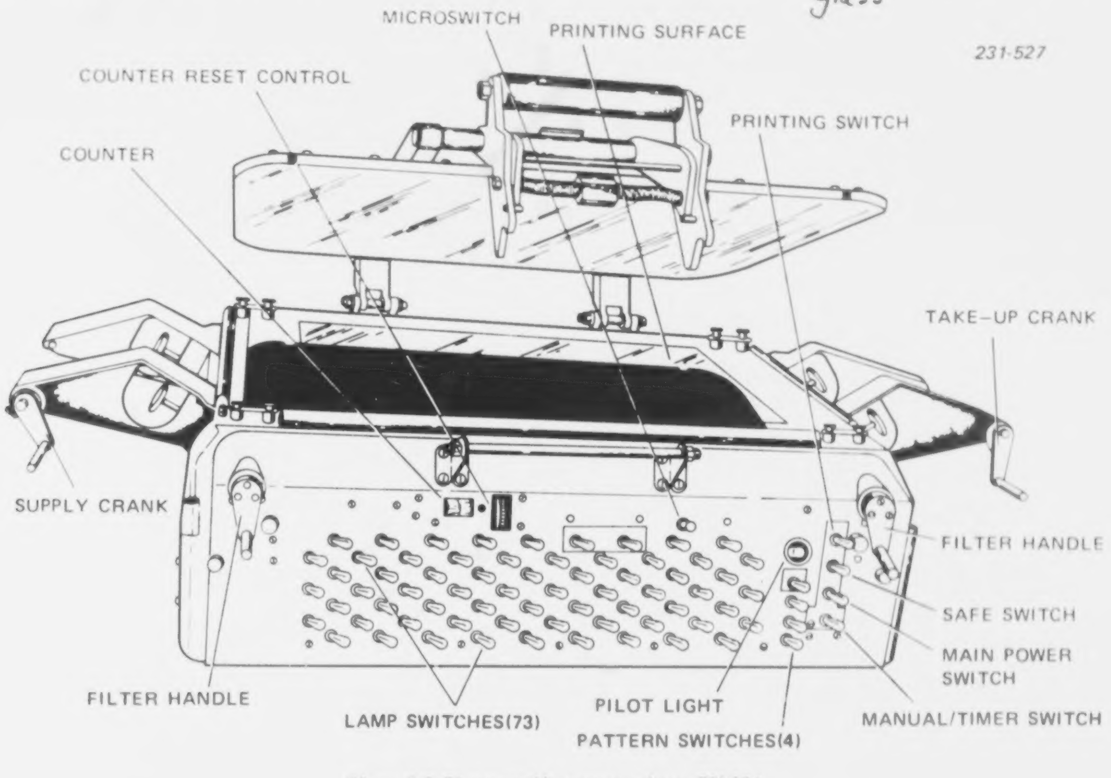


Figure 3-2. Photographic contact printer, EN-22A.

a. One clear printing glass. (You can use your own individually cut masks taped to the glass.)

b. One masked for 9 x 9-inch (22 x 22cm) negatives.

c. One masked for 9 x 18-inch (22 x 44cm) negatives.

Exercises (641):

Complete the following statements on the description of contact printers:

1. The negative and the paper are held down by the ____________ .

2. Precise exposure is available in most contact printers by the control of ________________________ .

3. The EN 22A can handle roll film negatives up to ____________ inches in width.

4. A roll ____________ is used for printing variable-contrast paper.

5. A sheet of ____________ glass is used to provide even illumination.

642. Specify techniques and procedures related to contact printing.

When examined under room lighting, a negative has a shiny side and a dull side. The shiny side is the film base; the dull side is the emulsion layer side. A similar examination of photographic paper shows that the paper has a slight curl toward the emulsion and, particularly with glossy paper, the emulsion side reflects more light.

To produce contact prints, the dull side of the negative must be in contact with the shiny side of the paper; that is, they must be emulsion to emulsion. If the negative base is in contact with the paper emulsion, the photograph will be reversed from side to side. In some cases, such a reversal in the print is not readily evident, but it becomes strikingly so if there are letters or numbers in the picture area.

The exposing light must pass through the negative first; therefore, in a contact printer, the exposing lights are directed upward. The negative is placed on the glass with the emulsion side up, and the paper is laid emulsion side down on top of the negative. Then the lid of the printer box is lowered to press the negative and paper together. (NOTE: To prevent slippage, it may be necessary to tape the negative to the glass. This technique is particularly useful when a large number of prints have to be produced. Later in the chapter, we refer to this glass when we discuss the use of masks.)

Earlier we mentioned that contact printing is used to make proof sheets. A proof sheet is made by printing strips of roll film negatives (35mm, 120, etc.) or individual sheets of cut film on one 8 x 10 sheet. A single exposure is given for all of the negatives. Because this is often a compromise exposure, some negatives will produce poor images. These negatives are separately grouped according to contrast and density; then they are reprinted. Proof sheets are excellent for record keeping and selection of negatives to meet mission requirements.

REMEMBER: the purpose of contact printing is to produce only image-size prints that reproduce the original scene from the negative as accurately as possible.

Exercises (642):

1. How should the negative and the print paper be placed on the contact printer for printing?

2. How can you determine which side of photographic paper is the emulsion side?

3. In contact printing, how should the size of the image in the negative compare with the size of the image in the print?

4. How should you make a proof sheet?

3-5. Projection Printing

Projection printing differs from contact printing in that the negative is separated from the sensitized paper. The negative image is projected by means of incandescent light and an optical system onto the sensitized paper. By altering the negative-to-lens distance and the lens-to-paper distance, it is possible to reduce, maintain, or enlarge the image size. Because most projection prints are made at an enlarged scale, it has become common to refer to projection prints as enlargments and to call a projection printer an enlarger. The preferred terminology is "projection printer," since the capability of reduction is present.

Today the skill of making prints by projection has become as necessary to the photographic technician as the making of contact prints. This situation has come about because projection printing offers many advantages over contact printing. The main advantage of projection printing is that the size of the prints can be regulated, irrespective of the size of the negatives. Other advantages are the ability to improve perspective, the ease of dodging, the larger choice of projection papers, and the many and varied special effects that can be obtained.

643. State some of the characteristics of projection printers.

Manually Operated Projection Printers. In general, all projection printers are quite similar in design and operation. They consist of an inclosed light source, some method of obtaining an even distribution of light over the negative, a negative carrier, a lens, a means of adjusting lens-to-negative and lens-to-paper distances, and an easel for holding the sensitized paper. It is necessary to have some way of changing the lens-to-negative distance for focusing and lens-to-easel distance for different degrees of enlargement or reduction. The degree of enlargement or reduction of an image is usually measured in terms of diameters. As an example, a two-diameter enlargement is twice the length and twice the width of the negative image (four times the area); and a three-diameter print is three times the length and width of the negative image (nine times the area).

Most projection printers have a tungsten lamp as a light source. The lamp is inclosed in a light-tight housing, which is ventilated to prevent excessive lamp heat from damaging the negative. Some projectors have blowers to circulate air and cool the inside of the lamp housing.

The negative carriers used in the projection printers may be either a dustless type or a glass-sandwich type. The dustless-type carrier consists of two metal plates with an opening in the center large enough to accommodate the negative format. The negative is placed between these plates and is held in position by its edges. This type of carrier is satisfactory for negatives 4 x 5 inches (10 x 13cm) in size or smaller, since these negatives have sufficient rigidity to remain flat. The glass-sandwich type of carrier consists of a holder with two sheets of glass, between which the negative is placed. A holder of this type is necessary for larger negatives, since they have a tendency to sag in the center if they are used in the dustless carriers.

The lens used in the enlarger should be free from optical defects and have an angle of field large enough to cover the negative being printed. A lens with a focal length approximately equal to the diagonal of the largest negative to be printed provides a sufficient angle of field.

The bellows of the projection printer should be capable of extending to at least twice the focal length of the lens. This amount of bellows extension is necessary for the production of 1:1 (same size) reproductions. Although it is possible to make a reduction to any desired size, the bellows on most projection printers cannot be extended far enough to make image smaller than 1:1. Smaller reduction may be accomplished by substituting a lens of longer focal length.

The methods used to distribute the light evenly over the negative divide projection printers into two general types—condenser and diffusion.

Condenser-type projection printer. The condenser-type projection printer, shown in figure 3-3, has a set of condensing lenses between printer light source and the negative. The condensing lenses concentrate or focus the light in such a manner that the rays pass straight through the negative to the projection lens. A projection printer with this type of light source reproduces the maximum amount of detail in the print. For this reason, negative defects such as surface scratches very often become apparent on the print. The condenser-type projection printer projects an image that is more contrasty than that projected by a diffusion-type printer.

Diffusion-type projection printer. The diffusion-type projection printer, shown in figure 3-4, has a diffusion medium between the light source and the negative. Light emitted from the lamp, as well as that reflected from the reflector, strikes the diffuser, which, in turn, scatters it in all directions. Thus when the light

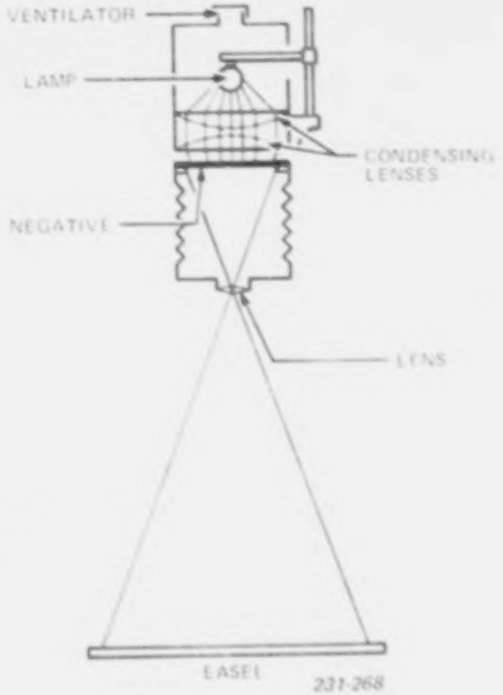


Figure 3-3. Condenser-type projection printer.

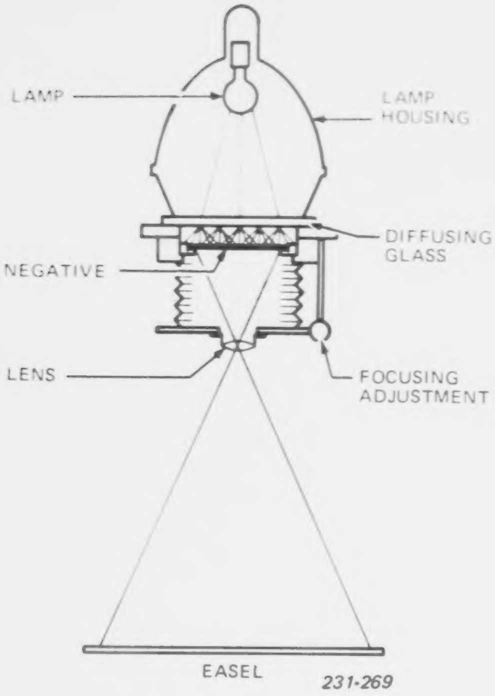


Figure 3-4. Diffusion-type projection printer.

reaches the negative, it is traveling in no specific direction but in many directions.

The effect of using diffused illumination is that minor negative defects are not clearly recorded in the print. There is a general softening of the image sharpness, which is accompanied by a reduction in image contrast. Diffusion-type printing is favored in portraiture and scenic-type work. However, the overwhelming majority of your Air Force printing is done on condenser-type enlargers.

Exercises (643):

Complete the following statements regarding projection printers:

1. Fine focusing is primarily controlled by the _____ distance.

2. The degree of enlargement is in terms of _______.

3. Negative carriers are either _______ or _______ types.

4. The enlarging lens normally has a focal length equal to the __________ of the negative.

5. A lens with a focal length longer than the diagonal of the negative being printed will project a _____ image.

6. A _________-type enlarger will project the more contrasty image.

7. A _________-type enlarger is good for printing negatives that have defects.

644. Specify operational characteristics and procedures of the EN-52B projection printer.

Characteristics of the EN-52B Projection Printer. The EN-52B projection printer shown in figure 3-5, is the type of projection printer you will find in your

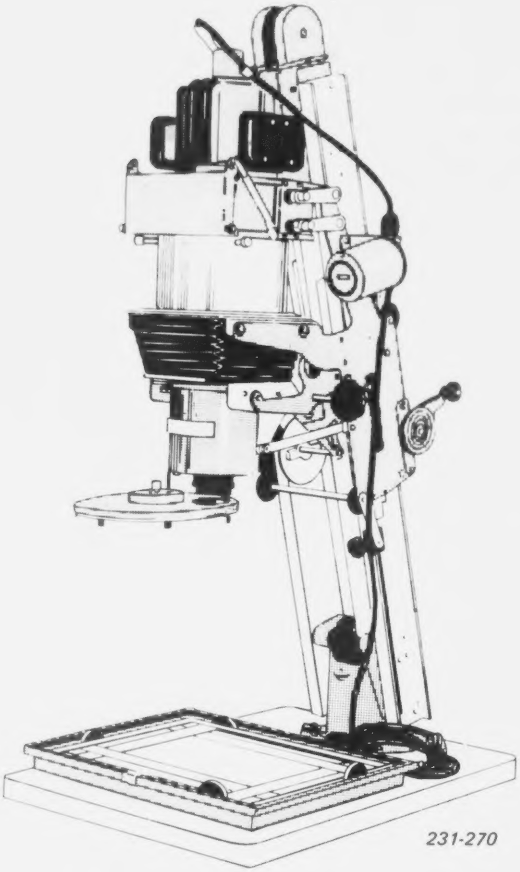


Figure 3-5. Projection printer, type EN-52B.

base photo lab. It is a table-size unit used to make enlargements of photographic negatives running from 35mm through 4 x 5 inches (10 x 13cm). Three lenses are available: f 3.5, 50mm (ideal for 35mm); f 4.5, 100mm (120 or 70mm film) and f 4.5, 150mm (4 x 5). The printer consists of 8 major assemblies. These units are the baseboard, easel, filter wheel, lens, negative carrier, condenser, lamphouse, and girder assemblies.

Operating The EN-52B Projection Printer. Use the following checklist when operating the EN 52B Projection printer:

(1) Make sure that the condenser, which is located immediately below the lamphousing, is securely locked in place.

(2) Slect the proper negative carrier for the negative(s) that you want to print and position a negative in the negative carrier so that the emulsion is facing down and the negative is upside down. Placing the negative upside down will make it project upright onto the printing easel.

(3) Raise the lamphouse condenser assembly, insert the negative carrier, and lower the assembly.

(4) Turn the overhead lights off, set the timer to the FOCUS position, place a sheet of white paper in the easel (a sheet of printing paper placed upside down can be used) and focus the image with the lens wide open and no filter installed under the lens.

(5) After initial focusing, raise or lower the projection assembly to achieve desired image size and cropping and refocus the image. Raising the assembly enlarges the image, and lowering it reduces image size.

NOTE: The EN-52B has the autofocus feature but it is set up to be used with a specific easel. Using an easel other than the one that comes with the projector changes the distance relationship that allows the autofocusing feature to work. Therefore, it is always good practice to refocus the image each time you raise or lower the projector assembly on its track.

(6) Once you have proper image size and cropping, tighten the tensioning knob on the projector track to lock the projector head in position. CAUTION: Always release the tensioning knob ~~that locks the pro-~~ before raising or lowering the projector head assembly, ~~on its track~~. If you don't release the tensioner, you may seriously damage the projector.

(7) To make a test print, set the timer to the TIME position and select an exposure time. Stop down your lens to the desired f/stop, remove the focusing sheet and insert a sheet of printing paper into the easel. Depress the timer button. The light will come on and stay on for the time that you set and shuts off automatically to end the exposure.

Exercises (644):

Complete the following statements related to the description and operation of the EN/52B:

1. When printing 120 film, you will normally use the __________ mm lens.

2. You can print up to a __________ negative on the EN 52B

3. The negative is inserted __________ side down to make the print.

4. The tensioning __________ knob must be loosened before you can raise or lower the __________.

5. To obtain maximum enlargement, it is necessary to __________ the ~~carriage and girder~~ projector head assembly.

645. Explain the problems encountered techniques used in projection printing.

The prerequisites for good projection prints are (1) good negatives, (2) a clean enlarger, (3) the proper contrast grade of printing paper or variable-contrast paper and filter set, (4) correct exposure, and (5) careful processing and finishing. As you can see, you must control a number of factors in order to achieve top-quality results.

Negative Selection. Although most any negative can be printed by projection, there are a few characteristics that are particularly desirable. A good negative has normal density and contrast. It is sharp and free from such defects as scratches, abrasions, dust, and fingerprints.

Your negatives should be handled carefully in order to prevent fingerprints and smudges that will degrade your image. Lint and dust particles hold back the light during printing, and their shadows produce white spots on the prints that are very unattractive additions to any photograph. Therefore, both the negative and the negative carrier should be cleaned with a tuft of cotton moistened in alcohol or film cleaner. If the negatives are properly processed and handled, however, they can usually be cleaned with a soft brush, lintless cloth, or air blasts from an aerosol can.

Printer and Easel Adjustments. Place the negative in the carrier so that the emulsion side is down and facing the emulsion of the paper. Replace the negative carrier in the projection printer and make sure that it is properly seated.

Adjust the paper corner guide and the masking device on the easel to form the border width and print size needed. As an aid for composition and accurate focusing of the image, place a sheet of white paper in the printing position on the easel. The base side of a finished print serves nicely for this focusing aid. Then turn on the appropriate safelights and turn off the white lights. Turn on the printer light and open the lens to its maximum aperture.

Focusing and arranging the composition of the projected image should be accomplished with the lens wide open. The brighter image is easier to see for accurate focusing. When you are ready to print, you should stop the lens down two or three stops for several reasons. First, almost all lenses project a sharper image when stopped down a couple of stops. Second, stopping down the lens causes a greater depth of focus, which provides a margin of safety for any slight error in focusing. Finally, moderate printing times (e.g., 10 seconds) permit dodging and burning in.

Now study the image carefully. (The picture is easier to compose if the scene if right side up. If it is upside down, either rotate the carrier or remove the carrier and reposition the negative.) Most printing papers are rectangular; therefore, you should decide whether to use a vertical or horizontal format. In many cases, the manner in which the scene is composed (horizontally or vertically) on the negative is the controlling factor. Furthermore, most photographs can be improved by cropping.

To bring the image to the desired size, raise or lower the printer head until the approximate size is reached. Then bring the image into sharp focus by changing the lens-to-film distance. However, because the size of the image will be changed slightly by focusing, the printer head should be readjusted. This readjustment involves moving the enlarger head and then refocusing. This operation should be repeated until the desired size is reached and the image is in sharp focus.

After the image is correctly composed and focused, the aperture of the lens should be closed down. Then turn off the printing light, remove the white focusing paper, and place the printing paper (emulsion side up) on the easel. You are now ready to expose and process your test strips.

Exercises (645):

1. What problem will dust and lint cause on your print? How can the problem be reduced?

2. How should the emulsion of the negative and the paper be arranged?

3. For a given negative size, how is image size controlled in projection printing?

4. In composing a picture, what two print formats can you normally choose from?

5. In terms of composition, why is projection printing more dynamic than contact printing?

3-6. Making Borders and Friskets

The white borders seen on most photographic prints are made at the time the paper is exposed. The masking techniques necessary to insure white borders varies, depending on whether you are doing contact or projection printing.

Another part of handwork at the printer is attaching friskets. In this section we discuss making borders and friskets.

646. Specify material types and procedures related to printing masks.

Contact Printing Masks. Many contact printers have part of the glass opaqued to form a mask. Thus the negative can simply be taped to the glass for printing. However, in most cases, a mask is constructed from four strips of opaque leader material. These strips are taped together at the corners to form a rectangular opening. A cardboard guide, made to the proper size, can be used as an aid in adjusting the size of the opening and alignment of the individual strips that form the mask. The opening must be a perfect rectangle with square interior edges.

The mask is taped to the printed glass, the negative is taped to the mask, and the paper is placed on top of the negative. This procedure prevents light from reaching the edges of the paper, thereby leaving a white border.

Masks may be constructed so that the border is of any desired size or even of a special shape. Masks with odd openings may be constructed for specialized purposes. You may want a circular border on a print, in which case the opening in the mask is round. Or, perhaps you desire an opening shaped like a keyhole or one imitating the effect of looking through a pair of binoculars. Unusual shapes may be effective in newspaper work.

Projection Printing Masks. In projection printing, it is the paper that is masked rather than the negative. An easel is used to keep the paper flat and to form a border. Easels come in a couple of basic designs. One type has a fixed frame for each size of print (8 x 10, 5 x 7, 4 x 5, etc.). Such an easel is immediately ready for use, and a piece of paper can be quickly inserted within the frame. Another common type has four masking strips that can be adjusted for any size of print or border. This type of easel has a guide to hold the paper. (There are also borderless, no-masking easels that use vacuum or other means to hold the print flat.) Easels produce square edges and are not meant to be bent into other shapes.

Exercises (646):

1. In contact printing, the ____________ is masked; whereas in projection printing, the ____________ is masked.

2. What type of material is used to make a contact printing mask?

3. What are the two basic types of printing easels that produce borders?

647. Specify how to attach a frisket to the printing easel.

Definition. A frisket is a piece of clear film or acetate on which printed words, symbols, or numbers can be clearly seen. Generally, a frisket is produced by typing the necessary information on a sheet of typing paper. This is copied and then contact printed on another sheet of film. The product is then a clear sheet of film with printing on it. The frisket can be thought of as a negative. The clear part allows light to pass through it, and the dark part transmits no light.

Uses. Any time you need to make information a permanent part of the print, use a frisket. UMRs, 36 93, and aircraft accidents are examples of photos that may require friskets.

Procedures. To get the frisket where you want it is no big problem. First cut the frisket to size. Leave enough area around the sides and bottom so that you can place tape there. Next, hold the frisket so that you can read it. Then put strips of tape on the back side of the frisket at the two edges that will be under the easel mask. The sticky part of the tape must be facing you. Now, put the frisket where you want it in the frame. Press the tape onto the easel frame. Finally check to see if the frisket has been properly positioned. This includes: (1) the frisket must be straight, (2) the frame must cover all of the tape, and (3) the frisket must lie flat. Your frisket and easel should look like figure 3-6 when you are done.

Exercise (647):

1. Briefly explain how to attach a frisket to a printing easel.

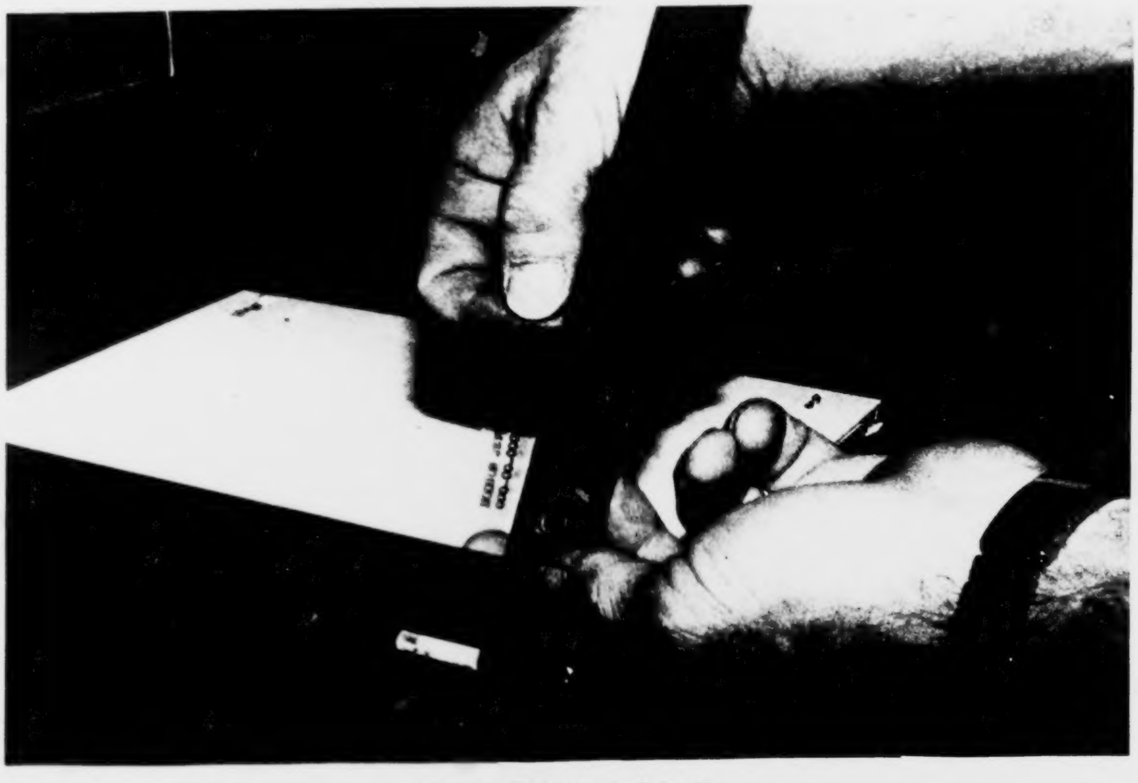


Figure 3-6. Frisket/easel relationship.

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3-7. Exposure Controls

Determining the correct exposure is as important in printing as it is when the photographer is exposing film in the camera. The basic formula, E = I × T, can be applied to printing. I represents the intensity of the printing light, and T represents the time the light is allowed to expose the paper.

648. Explain procedures and judging techniques related to the production of test strips.

The use of test strips is the best method to calculate exposure, whether you are contact or projection printing. Test strips are cut pieces of sensitized material that are each given different exposures. The strips are carefully processed and then compared under white lights. Using strips minimizes waste and insures good results.

When making a test strip, you can apply the following procedures for *either* contact or projection printing.

(1) Before exposing the test strip, choose the area of the negative or projected image that is to be used for the test strips. This area for the test should contain highlights, middle tones, and shadows. Each test strip should be made from the same part of the negative or projected image. Only in this way can one test be accurately compared with another strip. (Unfortunately, when making a projection printing test, too many technicians have been taught to use a full sheet of paper that is then progressively uncovered. This procedure results in the full image being sectioned off into strips of different density. Thus, there is no way of comparing the strips, since each may represent widely different ranges of negative density and contrast.)

(2) Cut a sheet of number 2 graded or variable-contrast paper into strips that are 2 inches (5 cm) wide.

(3) Carry out a systematic method of exposing, using a number 2 filter for the variable-contrast paper. For example, you can start with 2 seconds in the case of a projection printer (keeping the aperture the same throughout), and double the time period each time. Another method is to expose each test with an equal amount of increase. For example, 2 seconds could be added to each test. Such a system would give exposures of 2, 4, 6, 8, 10, etc., seconds. The main point is to be sure to bracket the correct exposure; that is, to go from underexposure to overexposure. (NOTE: Using a soft lead pencil, on the back of each strip, identify the exposure time used so that you will know the time that gave you your best result.)

(3) After you have exposed and labeled your strips, process them according to the manufacturers' directions for time, temperature, developer strength, and method of agitation.

(4) As soon as the test strips have been processed, carefully inspect them. By observing the highlight area, determine the best exposure for the grade of paper or variable-contrast filter tested. The highlight areas should be slightly darker than the same paper with no exposure, and they should contain detail. Too little exposure is indicated when there is no detail in the highlights. Too much exposure is indicated when the highlight areas are much darker than unexposed material. If the highlights are not correct on any of the test strips, run a new series of tests (using the same grade of paper or filter), providing more or less exposure as indicated.

(5) When the best exposure has been selected, decide whether the contrast is correct. Do this by examining the shadow area of the test strip that has the correct highlight exposure. If the shadow area of this test is too light, the paper (or filter) does not have sufficient contrast. Either a higher numbered graded paper or a higher contrast filter is needed. If the shadow area is too dark (i.e., the paper has too much contrast), a lower numbered graded paper or a lower contrast filter is needed. (Print contrast is discussed in more detail later in this chapter.)

Remember to continue to make tests until you have finalized the correct exposure time and grade of paper (contrast filter). It is cheaper to make a number of tests using test strips than it is to go off blindly on a trial-and-error basis with full sheets.

Exercises (648):

1. What is the purpose of making test strips?

2. Why are test strips economical?

3. Explain how to judge proper exposure by observing the highlight portions of a test strip.

4. Explain how to judge proper contrast by observing the shadow portions of a test strip.

649. Specify purpose and techniques used to control local exposure in printing.

Local Exposure Control. Many exposures are made under less than ideal conditions that wide variations of density in different areas of a single negative. That is, the exposure in one area of the negative is much greater or much less than in other areas of the negative. This characteristic is usually caused by wide variations in subject tones or the reflective qualities of the subject. In effect, the negative has a greater range of densities than can be reproduced by the printing paper. As a result, you have a negative that is very difficult to print. If the print is exposed long enough to bring out the details in the highlight areas, the shadow areas become overexposed. Or, if you reduce the exposure to retain detail in the shadow areas, the highlights are underexposed and lack detail. Since the objective of Air Force photography is to produce an accurate, detailed representation of the subject, you must often use special printing controls. The two basic controls you will be using are dodging and burning-in.

Dodging. Dodging is reducing exposure (density) in a particular area. The most common and the easiest method of contact-print dodging is through the control of the individual lights under various parts of the negative. The switches controlling lights under the areas of the negative that print too dark are placed in the OFF position. The lights are left burning under the areas of the negative that have the greatest density; thus, these ares of the print get more exposure than the areas of the negative that are above the extinguished lamps. If turning the lights off for the entire exposure time lightens the area too much, they may be extinguished for only a portion of the total printing time. On the other hand, if turning the lights off for the total printing time does not hold the light back enough, lamps surrounding the thin areas of the negative may have to be turned off in addition to those directly below the thin areas.

Dodging can be accomplished more easily and accurately in projection printing than in contact printing. As shown in figure 3-7, dodging may be done by manipulating your hands into various shapes. Or, as shown in figure 3-8, a dodging device can be made by attaching an opaque, properly shaped piece of material to a wire handle. Since the dodging tool is held and manipulated in the beam of light from the lens, its location and coverage can be seen and controlled during the printing exposure.

Dodging is generally necessary for only a part of the exposure time. When dodging, you should consider how close the tool is placed to the lens. The closer the dodging tool is to the lens, the larger the shadow it casts and also the more blurred the shadow becomes. Conversely, the shadow will be smaller and sharper, the closer the tool is held to the paper. To prevent the formation of a dodging tool outline on the print, the dodging device must be moved up and down and from side to side slowly and constantly in order to blend the areas receiving various exposures.

Burning-in. Burning-in adds exposure (density) to a local area of the print. Normally it is done after the basic exposure has been given to the entire print. In contact printing, the technique is little used but can be accomplished by turning off all the lights except those under the area to be burned in.

In projection printing, burning-in is done by using a piece of cardboard slightly larger than the print; the cardboard has a hole in the center, which is smaller but approximately the same shape as the area to be exposed. Figure 3-9 shows a simple device in use. After the normal overall printing exposure has been made, the burning-in device is moved into position between the lens and the easel. The card holds back all of the light except that passing through the hole. If the burning-in tool is held high, the circle will be large with blurred edges; if the tool is held low, the hole will appear smaller and have sharper edges. During exposure, the device must be kept moving in order to prevent the formation of an outline of the tool on the print.

Flashing. Flashing is the deliberate fogging of a print to darken specific parts of the print and to obscure detail. This technique differs from dodging and burning, whose purpose is to bring out detail. Flashing is done by exposing the print to raw light from the printer with the negative removed or by exposing the print using a flashlight.

Projection print flashing techniques use the light of the enlarger, with intensity being controlled by the lens aperture. To flash a print, remove the negative but leave the carrier in place to prevent a light leak. Hold a dark piece of cardboard, about 6 x 8 inches (15 x 20 cm) for an 8 x 10 print, with dull finish on both sides to prevent reflection, about 3 to 4 inches under the enlarging lens. When you are ready, hold the cardboard by one corner and move it back and forth very rapidly during the exposure. The area not completely covered during this rapid motion of the card will be flashed.

In order to use dodging, burning-in, and flashing effectively, you should make a fully corrected print. Study the print carefully and make your battle plan as to where you are going to dodge, burn-in, or flash. The applications of these techniques are time consuming; yet they make it possible to turn out a print that is rich in detail and mood.

Exercises (649):

1. Briefly state the purpose of dodging.

2. How do you dodge in contact printing?

3. What is the purpose of burning-in a print?

4. How do you burn-in during projection printing?

5. Why must your dodging or burning-in tool be constantly moved during exposure?

6. What is the purpose of flashing?

7. Briefly state how you flash a print.

3-8. Composition

Composition is the most visually effective way of arranging the various elements of the subject. When you make a print, the subject arrangement is set by the negative; but how much of the subject should be included and whether it should appear vertically or horizontally is up to you. In contact printing, you are limited to masking off unwanted edge areas, but in projection printing, you are much freer to determine the size and format of the subject. It is therefore important to consider composition when you print.

650. State basic principles and techniques applicable to printing composition.

Since photographers are of infinite variety, and they differ in their personal likes and dislikes, there are no hard and fast rules in composition. However, the following are some suggestions that can be used to produce a composition that is pleasing to most people. (Remember that the mission requirements of the Air Force must have the ultimate influence on the product.)

a. Normally, the center of interest (subject) is not placed in the middle of the print but a little to the left or right or a little above the center of the print.

Figure 3-7. Dodging procedures using the hand as a tool

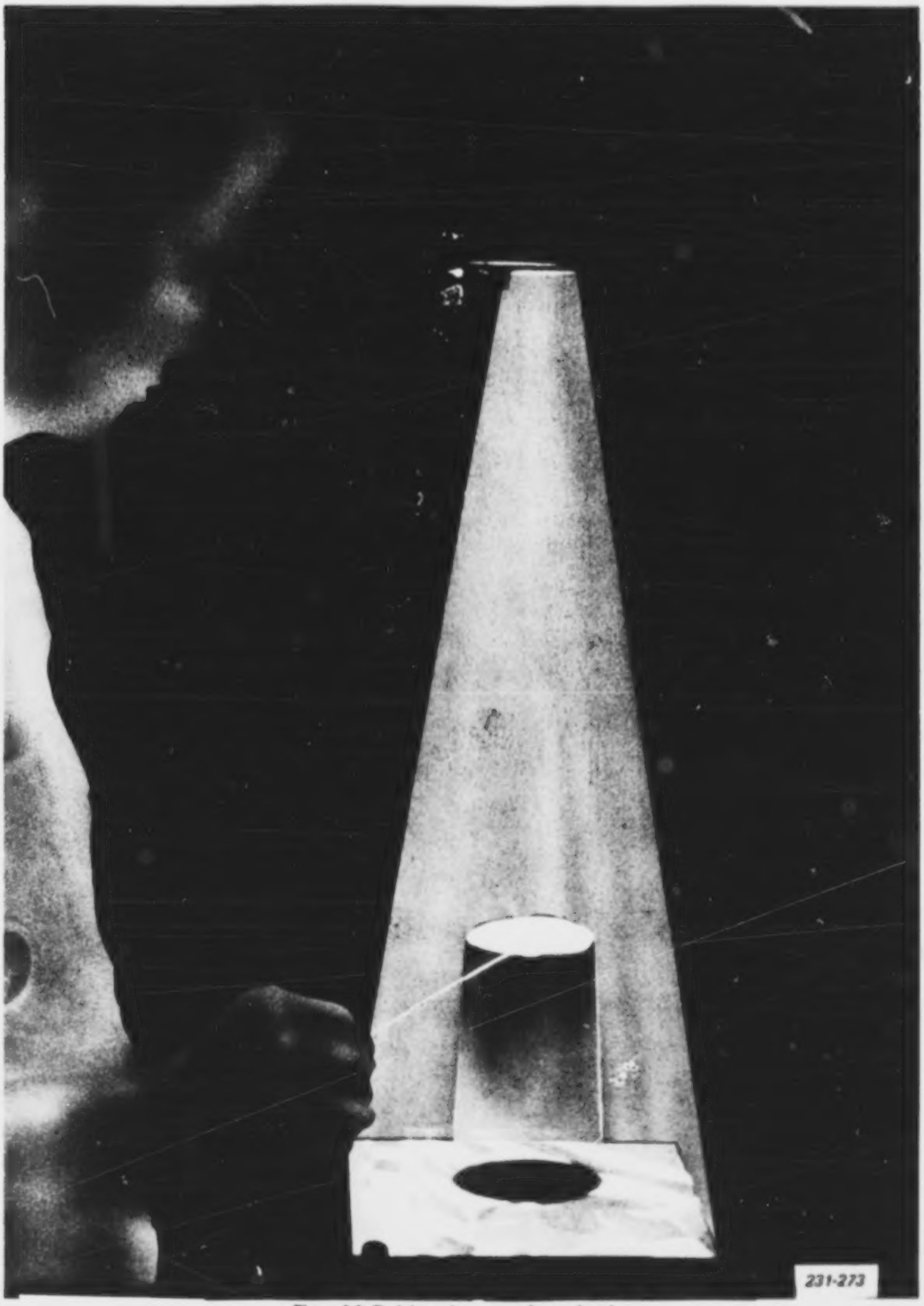


Figure 3-8. Dodging using a manufactured tool.

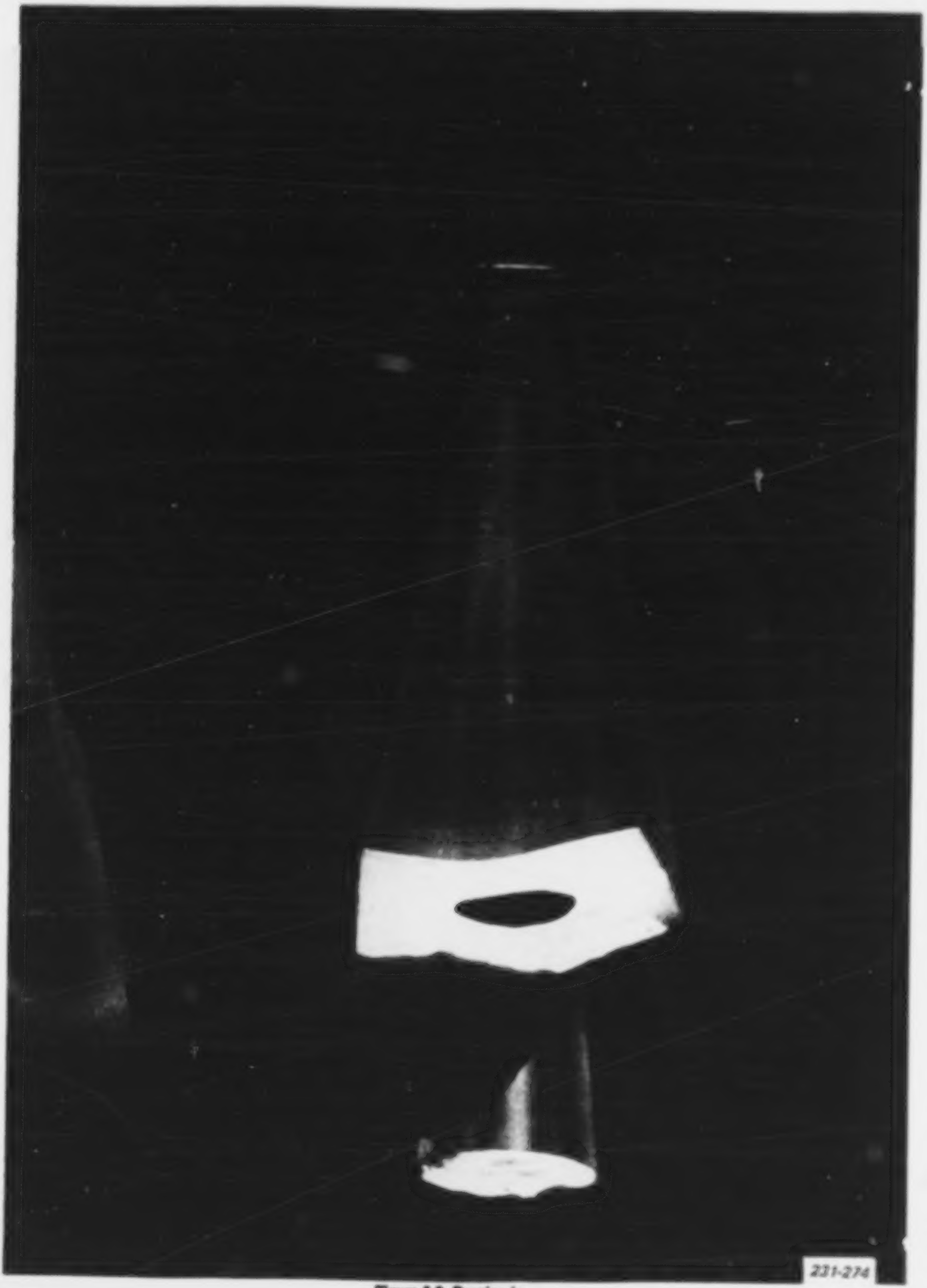


Figure 3-9. Burning-in.

b. Horizontal, vertical, or diagonal lines should never be allowed to cut the picture in equal parts. For example, the horizon should be below or above the center of the picture.

c. The horizon should be level.

d. Live subjects should be looking into the picture, not out of it. In other words, there should be more space in front of the figure than behind it. This principle also applies to action photographs: your composition is stronger if the action leads into the photograph and weaker is it leads out of it.

e. Let the subject determine whether it should be printed vertically or horizontally. Tall, thin subjects, such as portraits or buildings, work best vertically. Wide subjects, such as scenics, print better horizontally. If you have doubts, print it both ways and then decide.

To have a clear idea what the best approach would be, make a full-size test print. After processing and finishing, place the print under normal illumination and use L-shaped "rulers" to crop the picture. (The L-shaped cropping guides can be made from cardboard, etc.) Adjust the rulers until the image is the way you want it and then with a grease pencil, mark the picture. This indication then can be used when you make your final print. (Remember that when you change the image size of the print, you must make new test strips to determine the proper exposure, etc.)

Once you have decided what you want to do, then you can apply a number of different techniques.

The basic technique is to change the size of the image by changing the printer head/paper relationship. As the distance increases, the image becomes larger.

Another way to change image size is to change the focal length of the printing lens. The shorter the focal length, the larger the image for a given negative size.

Another technique involves the use of the easel. The easel can be placed horizontally or vertically anywhere within the projected image. It can also be laid at different angles to straighten a horizon line. If you have easels with adjustable blades and you are not held to a certain overall image size, you can crop by adjusting the blades.

NOTE: While not fitting within the topic of composition per se, remember that the tone and contrast of the image greatly affects the way people see your composition.

Exercises (650):

1. How should the horizon line appear in a print?

2. How should live subjects be arranged?

3. What are L-shaped rulers used for?

4. When should you switch to a printing lens with a shorter focal length?

5. What should determine whether the print is horizontal or vertical?

3-9. Distortion Control

Every photographer has discovered what is bound to happen if he tilts his camera upwards while taking a picture of a tall building—the vertical lines converge and the walls seem to be on the point of collapsing. In this section, we are not going to review how to shoot subjects like tall buildings, but we are going to describe how to correct for distorted images when you projection print. (No such correction is possible by normal contact printing.)

651. State the proper techniques to use when you must correct for distortion during projection printing.

A viewing camera is equipped with adjustments that permit making the film nearly parallel with the subject in spite of viewpoint. However, the press-type camera has only a rising front and a lateral shift of the front standard to accomplish any corrective action. Miniature and roll-film cameras rarely have means for correcting the alignment of the film and the subject. As a result of these limitations in taking the photograph, many negatives show a noticeable convergence of lines that is distracting. Changes in these images can be produced by manipulation of the projection printer to achieve the desired correction.

The control of distortion is based on the fact that image size varies with the distance between the negative and the easel. The greater the distance between the negative and the easel, the larger the size of the image produced. Thus, if the image is projected upon an inclined plane or the image is projected from an inclined negative, the portion of the image farthest from the negative will have the largest image size.

Conversely, that portion of the image being closest to the negative will have the smallest image size. If a negative consisting of parallel lines were to be projected from an inclined negative or onto an inclined plane, all portions of the negative would not be the same distance from the paper, and the lines would not be recorded as parallel. By the same token, a negative that has lines not parallel (within limits) could be projected so that the print will show them as parallel. The control of distortion is limited to some extent by the type of projection equipment available for making the print.

Tilting Only the Easel. Almost any projection printer has an easel that is a separate entity from the projector. Because the easel is separate, it can be tilted, even if it is merely propped up on one end. Study figure 3-10. Note that a small diaphragm setting is used to increase the zone of sharpness sufficiently to include both the part of the easel nearest the lens and the part of the easel farthest from the lens. Notice, too, that the zone of sharp focus is parallel to the negative in this case, and it is not parallel to the easel.

If parallel lines existed within the negative running in the direction A to B, these same lines on the print would tend to converge—being closest at B′ and the farthest apart at A′. Applying this principle to correct for convergence of lines, the end of the negative having the lines closest together would be placed at end A of figure 3-10. The end of the negative having the lines farthest apart would be positioned at B. (However, realize that the ends of the negative could be reversed if the tilt of the easel were also reversed.)

One of the big disadvantages of tilting only the easel is that an extremely small diaphragm opening must be used to have sufficient depth to the zone of sharp focus. The use of a small diaphragm opening makes it necessary to use longer exposure times.

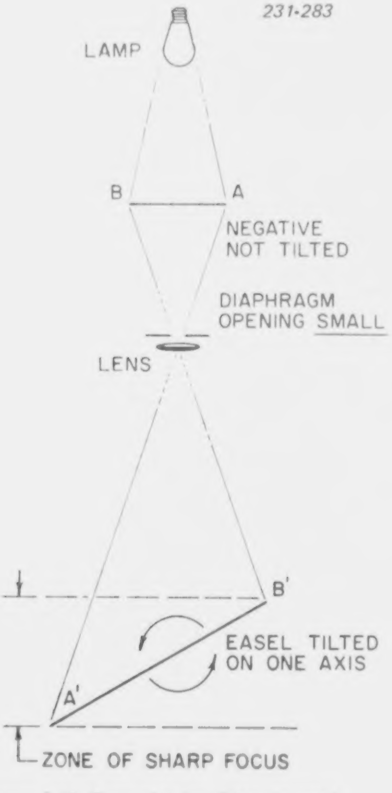


Figure 3-10. Correction by tilting the easel.

Tilting Only the Negative. If the negative were tilted instead of the easel, as is shown in figure 3-11, the result would be much the same as when the easel is tilted. Once again, a very small diaphragm opening would be necessary to produce a zone of focus with sufficient depth to be sharp at both ends of the easel. Notice that the zone of sharp focus titlts on the same axis but in the opposite direction of the tilt of the negative.

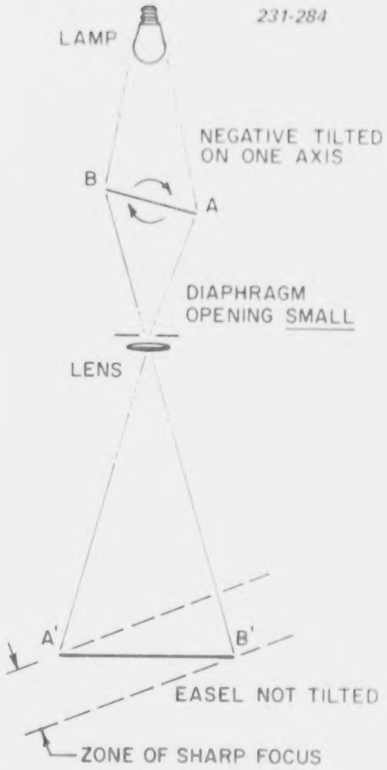


Figure 3-11. Correction by tilting the negative

Since the same negative-easel relationship exists in figure 3-11 that existed in figure 3-10, the effect of the tilt on the image would be the same as that resulting when the easel was tilted. When the negative is tilted, the same disadvantages also exist; that is, it is essential to use a very *small* diaphragm opening to provide the required depth in the zone of sharpness.

Tilting Both the Easel and the Negative. If you carefully examine figures 3-11 and 3-12, you will notice that if both the negative and easel were to be tilted on the same axis but in opposite directions, the correction would be the same. In addition, the plane of sharp focus would be parallel to the easel. Thus, an arrangement such as that shown in figure 3-12 works very well for the correction of distortion when the distortion is on a single axis. Since the plane of sharp focus coincides with the tilt of the easel, the diaphragm aperature can be relatively large.

Not too many projection printers are equipped with negative carriers that can be tilted at will. But remember, many printers are designed so that the entire projection head can be tilted. This tilting, in effect, is the

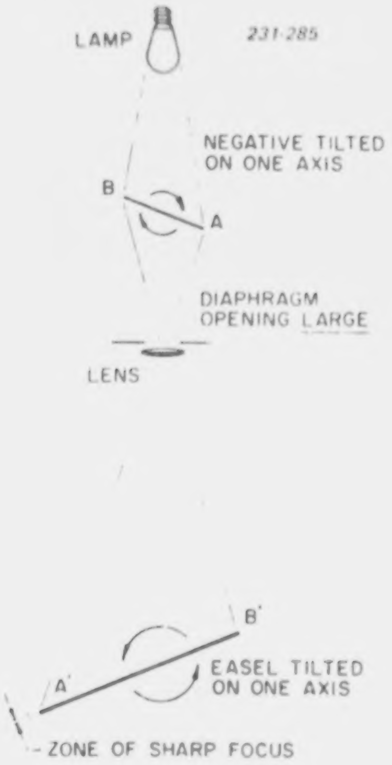

LAMP
231-285
NEGATIVE TILTED ON ONE AXIS
B
A
DIAPHRAGM OPENING LARGE
LENS
B'
A'
EASEL TILTED ON ONE AXIS
ZONE OF SHARP FOCUS

Figure 3–12. Correction by tilting both the negative and the easel.

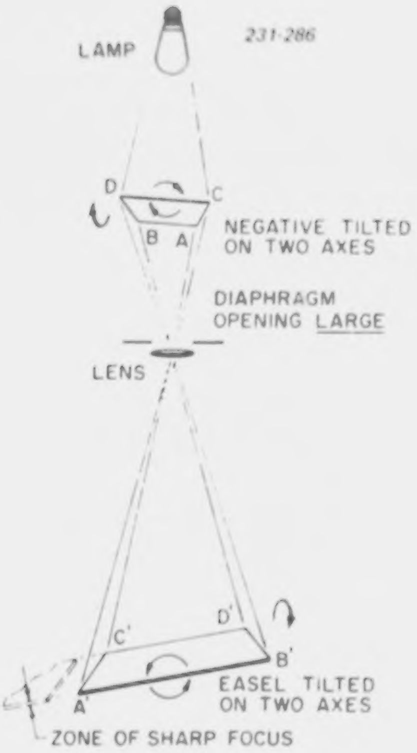

LAMP
231-286
D
C
B
A
NEGATIVE TILTED ON TWO AXES
DIAPHRAGM OPENING LARGE
LENS
C'
D'
B'
A'
EASEL TILTED ON TWO AXES
ZONE OF SHARP FOCUS

Figure 3–13. Correction by tilting both the negative and the easel in two directions.

same as tilting the negative. The negative-to-easel relationship is the significant point you must remember.

Tilting Both the Easel and the Negative on Two Axes. Certain projection printers are equipped with both a two-axes tiltable negative carrier and a two-axes tiltable easel. The type of arrangement shown in figure 3-13 is ideal for correction of distortion. Distortion in any direction of distortion. Distortion in any direction on the negative can be corrected, and the zone of sharp focus can be made to coincide with the easel in its tilted position. Correction of distortion on both a horizontal axis of the negative and a vertical axis of the same negative is possible. Large diaphragm openings are possible without seriously affecting image quality.

Exercises (651):

Complete the following statements on distortion control

1. When tilting only the easel for distortion control, you must use a __________ diaphragm setting.

2. When tilting only the easel to correct for distortion, you tilt the easel __________ where the projected image's parallel lines are farthest apart.

3. When tilting only the negative, you must use a __________ diaphragm.

4. When you tilt both the easel and the negative, you may be able to use a __________ diaphragm.

5. More complete distortion correction is possible when the easel and the negative can be corrected on __________ axes.

3-10. Negative Duplication ——

Duplicate negatives are often required for distribution to other agencies for printing or for filing and storing in different locations. At times, it may become necessary to send duplicate negatives to other bases for making prints to be used for operational, instructional, or publicity purposes. Duplicate negatives are ideal for training and practicing techniques (like etching).

A negative also may be duplicated in order to have a reserve in the event the original is lost or damaged. Duplicating the negative is particlarly important when it is impossible to make a new negative of the subject by reshooting it.

In addition, duplicate negatives are used when it becomes necessary to speed up production or when a large number of prints of the same subject must be produced. This mass production can be accomplished by making a number of duplicate negatives of the original and distributing them to the various printing stations. Several technicians can then be simultaneously working to meet production requirements.

Some defects in negatives can be corrected during duplication. For example, you can change the contrast or density of a negative. You can dodge or burn in any local area of the negative. Of course, you cannot impart detail that is not present in the original.

For these and other reasons, you should know how to duplicate negatives.

652. Specify techniques for making duplicate negatives, stating advantages and disadvantages.

Duplicating by Contact Printer. If the duplicate is to be the same size as the original negative, contact printing is the easiest and most economic method. The positive-negative film method is simple to accomplish. First, contact the negative with a fine-grain copy film like Kodak's Ortho 4125. After the film has been processed and finished, you have the master positive. From the master positive, if you repeat the same contact printing steps with your copy film you can turn out as many duplicate negatives as needed.

To insure good results, remember the following points:

a. The film you use to make your master positive or duplicates may have much different sensitivity than the print papers that you are using. Watch those safe-lights! Make sure that they are the type recommended for your film. Your exposing times may also be shorter than you are used to.

b. Make sure that the original negative, the master positive, and the film are clean. If you don't, you will have dust spots in the image that cannot be removed.

c. You can dodge, burn in, or change the contrast (by exposure and development combinations) of the master positive. But remember, your aim is to obtain negatives that can produce prints that are as good as (or better than) those produced by the original. Your master positive and duplicate negatives should not normally be high-contrast. They should contain a full range of tones that match the original negative.

d. You should carefully choose your film/developer combination for each step. Duplication magnifies grain, and so by the time you have made your positive and your duplicate negatives, the grain of the original will have been magnified. This magnified grain could ruin your prints. Keep grain down by using fine-grain film/developer combinations.

Duplication by Projection Printing. When the duplicate negative must be a different size than the original, use the projection printer. Projection printing gives you much greater control over dodging and burning-in when you make your master. Once the master positive is made, you can contact print the duplicate negatives.

Reversal Film. An alternative to the positive/negative method is to use reversal film, which can produce the negative in one step. Its drawbacks are the limited number of black-and-white reversal films (mainly 35mm) and the more elaborate processing that is required.

Direct Duplicating Film. Another method of duplicating negatives is to contact or projection print them onto direct duplicating film. Use such films as Kodak Direct Duplicating Film, types 2575 or 4575. This film produces a negative in one step (no intermediate positive is needed). Although it is a high contrast film, moderate success with continuous tone negatives is possible by selecting a developer which will reduce contrast. Try such developers as HC 110 dilution B, D–72 or Dektol 1:1, or Polydol. When duplicating high contrast negatives, select a high contrast developer such as D–11, D–19, etc.

Exercises (652):

1. How can you produce duplicate negatives, using contact printing?

2. What are the advantages of making a master positive by using projection printing?

3. What are the possible drawbacks of using reversal film?

4. What type of contrast does direct duplicating film have?

3-11. Storage and Preservation of Papers

Photographic papers are perishable and deteriorate with age. They must be protected primarily from the injurious effects of heat and moisture, as well as from harmful gases and from physical damage. Inadequate protection in storage causes increased fog, inferior tone reproduction, and a loss of emulsion sensitivity, as well as such physical defects as shrinkage, distortion, and brittleness.

653. Specify the procedures for the proper storage and preservation of photograhipc paper.

Manufacturers package their products either for domestic use or for export. Materials intended for export, or for use when high relative humidity is prevalent, are packaged in moisture-proof containers. Packaging for export is so labeled on individual units as well as on the shipping cartons. Materials intended for normal domestic use may be packaged in moisture-resistant, but not in water-tight or vaportight containers. Assume that an unlabeled package is intended for domestic use, and handle it accordingly. Do not keep sensitized papers under refrigeration once the sealed package has been broken, unless the refrigerator can be held at 50 to 60 percent relative humidity.

Store individual packages of paper on end so that the weight of the contents is on the edges of the paper.

Also, store material with the earliest expiration date to the front of the stack—this procedure enables you to use the oldest material first. However, when it is known that the paper due to be used next (according to the earliest expiration date) has been shipped or stored under unfavorable conditions, you should set this material aside and use fresh material for any highly critical project you have to print.

Paper removed from cold storage areas must be adjusted to room temperature over a period of at least 8 hours prior to use; longer times are required for warmup if the packages are stacked.

Processed prints require the same careful protection that processed negatives should receive. Moisture, light, heat, chemical fumes, and careless handling can cause permanent damage. Prints should be carefully filed in manila envelopes that are kept in appropriate storage vaults in an air-conditioned room. The relative humidity should be kept between 40 to 50 percent and the temperature near 70° F. (21° C.).

Exercises (653):

Complete the following statements on the storage and preservation of photographic paper:

1. Packages of paper should be stored so that the weight of the contents is on the ____________ of the paper.

2. Older paper should be stored towards the ________ of the stack.

3. Paper removed from storage needs to be ajusted to room temperature over a period of ____________ hours prior to use.

4. Processed paper needs to be protected from ____________ , ____________ , ____________ , ____________ ____________ , and ____________ ____________ .

5. Prints should be stored in a room having a temperature near ____________ .

3-12. Operator Maintenance

In addition to all the other potential problems in the darkroom, there is the possibility that equipment will not work. To make sure that your equipment works well, you practice operator maintenance.

654. Specify the proper procedures for operator maintenance on printing equipment.

In your printing room you have equipment that must work properly and consistently. Consider a timer that occasionally takes one minute, sometimes one minute and ten seconds to do a full circle. Not very consistent, is it? You may have a projection printer that slides down the track because of a loose locking screw. It would be difficult to produce a good print while the lens assembly was moving to the easel. A contact printer with a hole in the platen will not produce very sharp prints.

As in so many other areas, operator maintenance of printing equipment is basically common sense and good housekeeping.

A contact printer must be kept clean. You should check to see if each bulb is working. Replace those tht are burned out. While you are checking for good bulbs, check the operation of each switch. Identify those that do not work and have them repaired by maintenance people. Make sure each piece of electical equipment is properly grounded. The platen must hold air. Check it for leaks or cracks.

Projection printers also need to be checked for proper operation. Look for loose nuts, bolts, and screws that you can tighten yourself. Make sure that electrical cords are not frayed and that each three-prong plug has all three prongs. Look at each negative carrier to see if it is still square and that those with glass do not have broken, chipped, or scratched glass. Burrs in the metal carriers can also scratch your negatives. If you find any burrs, file or sand them smooth. Check the lens cones for proper fit. The lens should be secure and clean. Periodically clean the condenser and/or diffusion glass. Be careful when handling them as they are generally expensive.

Check the timers, both interval and continuous, for proper and safe operation. Electrical work on timers must be done by qualified people, but you can identify malfunctions. Keep the timers clean and do not put them where water and chemicals can be splashed onto them.

About all you can do for an easel is to be sure the hinges work. Check adjustable easels for free movement of the border masks and ensure that they are not bent.

Keep all of your printing equipment clean. This will keep it working longer and will give you a better place to work in.

Exercises (654):

1. List three things you should check on a contact printer.

2. What should you look for when you perform operator maintenance on negative carriers?

3. What precautions should you take when you position a timer?

Black-and-White Finishing

FINISHING YOUR prints is the final step in the printing cycle. It includes all of those actions you take after the print has been removed from the fixing bath. Your print finishing operations will include washing, glossing, drying, identifying, and mounting—all of those things needed to put the "finishing" touches on your prints.

In this chapter we present information that you should learn in order to be an efficient print finisher. A thorough knowledge of finishing techniques is necessary if you are to turn out high quality prints that meet the mission requirements.

4-1. Washing Prints

Washing is an important step to insure a permanent image. It should never be done in a haphazard manner. You must, therefore, learn proper washing techniques and then apply them in your work. This section discusses basic principles of washing prints and the use of mechanical washers.

655. State principles and describe procedures related to print washing.

The purpose of washing prints is to remove the residual chemicals that remain in the emulsion base of the paper after development and fixation. Washing dissolves and dilutes the soluble products and eliminates them with the disposal of the wash water. Thorough washing of prints is as necessary as thorough washing of negatives. If processing chemicals remain in the paper, they will discolor and ruin the print. Although chemicals diffuse from both the base and the emulsion of prints during washing, it is necessary to wash prints longer than the time required for negatives because the fibers and baryta coating of the paper absorb the chemicals. (An exception is resin-coated paper, which can be washed in 4 minutes because it does not absorb chemicals at the same rate as other papers.)

Washing Factors. ~~The~~ length of washing time is dependent upon a number of factors. You should consider the following:

a. Proper fixing. Using partially exhausted fixing baths that require longer than normal fixing times will require longer than normal washing times.

b. Temperature of the water. The higher the water temperature, the faster the chemicals are diffused. Therefore, you get faster washing times at 75° F. (24° C.) than at 65° F. (18.5° C.). (Very high temperatures will damage the emulsion.)

c. Type and weight of the paper. Whether the paper (*is* or *is not*) resin-coated affects the washing rate. Resin-coated papers do not absorb the chemicals as do the normal kinds and therefore wash faster. The weight of the paper is significant. Double-weight paper, which is thick and therefore absorbs more chemicals, takes about twice as long as single-weight paper.

d. Method of washing. Whether you are using trays or mechanical washers will significantly affect the water exchange rate and hence the washing times. Mechanical washers, in fact, are a necessity for high-volume washing.

e. Rate of water exchange. The number of complete changes of water to insure that the contaminated water is being completely drained away is important. One change every 5 minutes is recommended to insure proper washing.

f. Amount of agitation. Agitation is essential to insure the free flow of water around each print. The prints must be rotated by hand or tumbled by mechanical means so that each print is adequately washed.

g. Use of a hypo clearing agent. The rinsing of prints in a hypo clearing agent for 3 to 5 minutes prior to washing can significantly reduce washing times. There are a number of commercially made hypo eliminators, and formulas are also given in the Photo Lab Index. Using these solutions according to directions can save you much time.

Washing By Trays. Although most washing is done by mechanical washers (discussed later in this section), small groups of prints may be washed in trays. Two deep trays should be used. The size of the trays selected is determined by the size and number of prints to be washed. Both trays should be filled with water. All prints are then placed emulsion up in one tray. The prints should be separated, agitated, and then transferred one at a time to the other tray. The first tray is then emptied and refilled with fresh water, and the procedure is repeated until the wash is completed. The prints should be agitated by rotation at least two or three times in each change of water and the water changed at 5-minute intervals until about six changes have been given for single-weight prints. Double-weight prints should be given from eight to ten changes.

A second method of washing prints in a tray involves the use of a tray siphon. The siphon directs fresh water into the top of the tray and at the same time removes the chemically contaminated water from the bottom of the tray. The tray siphon method of washing is quite efficient.

Exercises (655):

1. List seven factors that determine print washing times.

2. If a print is not properly washed, what will happen to the image with the passage of time?

3. How often does the water have to be changed when you wash by tray?

4. What is the advantage of washing at 75° F. (24° C.)?

5. Why does it take longer to wash double-weight prints than single-weight ones?

656. Differentiate between effective and ineffective procedures related to the operation of print washers.

Mechanical Washer. A convenient method of washing large numbers of small- and medium-size prints is by the use of a mechanical washer. The majority of your print washing may be carried out by using this item of finishing equipment. Average washing time for non-resin-coated, single-weight prints is less than 30 minutes; double-weights take about 45 minutes to an hour. A mechanical washer sprays fresh water into a rotating drum and at the same time drains off the contaminated water. The rotation of the drum, together with the spray of the water, gives constant agitation to the prints. In mechanical washers, the water is completely changed every few minutes.

Pakolux. A typical mechanical print washer is the Pakolux shown in figure 4-1. The machine washes large numbers of small photographic prints quickly and efficiently. It washes approximately 100 double-weight 8 x 10s in 45 minutes.

To operate the Pakolux, you should follow these instructions:

(1) Close the drain valve so that the tank can be filled.

(2) Open the water shut-off valve and allow the tank to fill to the overflow level. By setting the shut-off valve from one-half to three-quarters open, you can maintain a continuous flow of fresh water.

(3) Raise the drum by stepping on the foot pedal and depressing it far enough to engage the pedal lock. Manually rotate the drum until the door in the cage is rotated to the top where the index pins on the lift channels hold the drum in place. Release the locks and open the door.

(4) Place the prints in the drum one by one so that they do not stick together. Close and lock the door. To lower the drum into the tank, push down the foot pedal to release the pedal lock. Allow the pedal to rise slowly. Apply power to the motor by turning on the electrical switch.

(5) When the washing is completed, turn off the power. Slowly raise the drum and lock it in position with the foot pedal. After the drum is rotated in the index position, open the door. Place the prints on the door for a short period to drain off excess moisture.

(6) When all prints have been removed from the washer, close the shut-off valve and open the tank drain valve. When the water has drained out, wipe down the washer with a clean dry cloth.

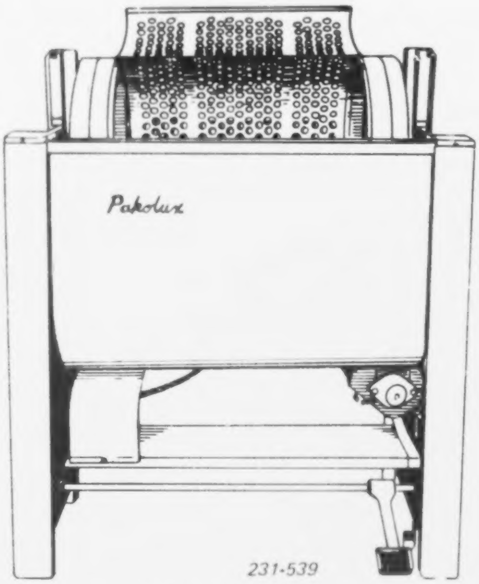


Figure 4-1. Pakolux print washer.

Remember to consult the applicable technical order prior to and during operation.

Exercises (656):
Indicate whether each of the following statements regarding machine washing of prints is true or false.

T F 1. Mechanical washers are better able to wash a number of prints than a tray washer.

T F 2. Mechanical washers use the principle of aeration to provide adequate print agitation.

T F 3. When the Pakolux washers is in operation, both the shut-off valve and drain valve should be fully open.

T F 4. The vertical position of the Pakolux drum is controlled by a foot pedal.

T F 5. To fill the tank of the Pakolux, the drain valve must be opened.

4-2. Print Drying

The process of print drying is not the uncomplicated task that it appears to be. It involves a combination of variables, most of which can be satisfactorily controlled. In this section we discuss basic drying principles and the operation of mechanical dryers.

657. Specify operational principles and problems of print drying.

Print Drying Principles. The basic principles of drying paper are similar to those of drying film which we discussed earlier. The main difference between drying film and drying paper is that the paper backing contains a great deal more moisture than the transparent backing of film does. When you are drying transparent materials, your main concern is the removal of moisture from the emulsion. When drying papers, you are still concerned with removing the moisture from the emulsion, but you are also concerned with removing the large amount of moisture from the paper backing. Often you will find that removal of the water from the paper is a greater problem than the removal of the water from the thin emulsion.

Predrying Treatment. Frequently, the emulsion of prints is so hard that the prints tend to curl and the emulsion cracks when any attempt is made to straighten them. This is usually the result of using too much hardener in the fixing bath or removing too much moisture from the gelatin of the emulsion during the drying step.

One method that can be used to minimize this condition is to soak the prints in a softening bath after washing has been completed and prior to drying. Besides softening the gelatin of the emulsion, the softening bath also tends to make the paper base more flexible and in the case of glossy prints the solution adds to the gloss. Prints treated in the softening bath curl less and are more easily flattened because of their increased pliability.

A suitable bath can be made by adding 1 part of glycerin to 10 parts of water. If glycerin is not available, carbitol acetate (also known as diethylene) and other commercial products may be used. When prints are soaked for a 5-minute period in this softening bath, they are usually softened sufficiently for normal use. Occasionally, it may be necessary to increase the concentration of the solution and/or increase the time that the prints are in the bath. After the bath, the prints are not rinsed but are merely drained, squeegeed on the back, and dried. Hence, you should be sure that washing has been thorough and complete before the bath is used.

Drying Prints Between Blotters. Many times it is considered advantageous to dry prints between photographic blotters. These blotters must be lint free. Drain the prints well and place them between two blotters to remove all of the surface water. Then place the prints flat until the circulation of air dries the moisture from the emulsion and paper. When several prints are to be dried in this manner, you should use corrugated cardboard between each combination of two blotters and prints. Air can then circulate through the stack, and drying is speeded up. This method of drying works well when there is no need for immediate use of the prints. This method of drying produces a nice, flat print.

Drying Prints on Racks. The procedure for drying prints on racks has the big advantages that no change in prints tone occurs and both stretching and shrinking are minimized. For these reasons, the rack-drying procedure is normally used when prints are being prepared for a controlled, photographic mosaic.

Drying Prints on Ferrotype Plates. A ferrotype plate or ferrotype tin is a metallic sheet having a highly polished surface which is usually chromium-plated. Ferrotype plates are also made of polished stainless steel. The principle of the ferrotype plate is that the surface of the wet glossy-surfaced print is pressed against the surface of the plate. As the print dries, it takes on the exceptionally smooth surface of the ferrotype plate. Because of the extremely high polish of a good ferrotype plate, the print dries with a very high gloss. The procedure used is to take the wet print that has been fully washed and treated in the glossing or softening solution and place it on the ferrotype plate. The emulsion of the print must be facing the glossy surface of the ferrotype tin. When the print is in this position use a squeegee or print roller to remove all of the excess water and any air bubbles. After the print is in good contact with the plate, it is allowed to dry. When the print is dry, it usually falls away from the plate. (Occasionally, a print may not fall off; but by lifting one corner with the fingernail, it becomes free and falls away.)

The polished surface of ferrotype plates must be absolutely clean and free of scratches. Any dust, dirt, lint, or other foreign matter on the surface of the plate is transferred to the surface of the dried print. Cleanliness and care of ferrotype plates is absolutely essential.

Common Problems Encountered in Print Drying. Some of the problems encountered in print drying are tied directly to specific drying methods, but other problems are common to all print drying. Let us discuss some of the common print drying problems.

Curl. As a print dries, the gelatin shrinks. The more it shrinks, the greater the tendency for curling. The curl is actually caused by the gelatin shrinking more than the paper backing. The most effective method of preventing curl is to dry the print in either an absolutely flat position or a position that causes the emulsion to be stretched; that is, in a position that is reverse to the curl inherent in the paper. If the print is allowed to dry in this position, the tendency to curl is minimized.

In extremely dry climates, you may need to use flattening solutions that help the gelatin to retain its moisture content. If you soak the prints for sufficient time to allow the flattening solution to thoroughly saturate both the emulsion and the paper before you dry the prints, you can keep curling at a minimum.

Shrinkage. The problem of shrinkage is not important for ordinary prints, but when the prints must be used for taking measurements or for assembling controlled mosaics (e.g., maps), shrinkage becomes very serious. Print shrinkage is caused by gelatin contraction and or paper contraction. The contraction makes the print surface occupy less area than it did at the time it was exposed. Dimensional accuracy can best be achieved by drying the prints slowly and by not subjecting them to any stress before, during, or following the drying process. When they are available, use special dimensionally stable papers.

Cracks. If the emulsion of a print contains cracks, it very often indicates that there has been rough handling of the material. The improper handling may have taken place before exposure, during processing, during drying, or subsequent to drying. If the emulsion of the paper contains the right amount of moisture, it can take a great deal of flexing without cracking. However, if the moisture content drops below normal, the gelatin becomes quite brittle and may crack when it is bent. Excessive hardening of the emulsion and drying at too high a temperature may cause the gelatin to crack more easily. Cracks can result when a print straightener, which bends the print in a reverse curl around a roller, is set to bend the material too sharply.

Change in tone (plumming). When photographic papers are dried by heating, they may change tone. They tend to change toward a colder, more purple color. The effect is dependent upon the amount of heat used, the nature of the sensitized materials, and the tone of the image prior to drying. To prevent plumming, your prints can be soaked in an antiplumming solution prior to drying.

Changes in the appearance of the print surface. When matte and semimatte papers are dried by heat, the surfaces sometimes have a higher sheen than if they are dried naturally. Starch grains are included in the emulsion to provide matting. The rising temperature of the paper causes these grains to burst. While this effect may improve the appearance of some semimatte papers, it is normally considered detrimental for prints on most matte papers.

NOTE: You will probably find that the new resin-coated printing papers are free from many of the print drying problems we have discussed.

Exercises (657):

Complete the following statements related to the principles and problems of print drying.

1. Drying prints takes longer than drying film because prints have a ____________ ____________ .

2. A suitable softening and glossing bath can be made by adding 1 part of ____________ to ____________ parts of water.

3. Drying prints on racks minimizes ____________ and ____________ .

4. A metallic sheet having a highly polished chrome surface is called a ____________ ____________ .

5. When the gelatin of the paper shrinks faster than the paper, the resulting print will have ____________ .

6. A ____________ ____________ solution is used in dry climates to help the gelatin retain moisture.

7. If the emulsion becomes too dry, the paper is likely to ____________ when bent.

8. Shrinkage is a serious problem in prints being used to make ____________ .

9. ____________ is a change in the print tone, usually resulting from drying with heat.

658. Specify operational characteristics and procedures for print dryers.

You will dry the majority of your prints by using mechanical dryers. Therefore, we cover the operation of a typical belt dryer suitable for all your conventional print-drying needs. You should note that when you are printing with resin-coated paper, the prints should be air dried or you should use the new types of dryers designed for resin-coated paper.

Belt Dryers. The majority of prints made on conventional fiber-base papers are dried on the motor-driven, belt-type dryer. A belt dryer consists of a drum, over which a wide, endless cloth belt or apron travels. The drum is motor-driven and is heated by electricity or hot water. The drying rate for prints is regulated by the temperature of the drum and the speed at which the drum rotates. The drum temperature is controlled by a thermostat, while the drum rotation speed is regulated with a variable-speed motor control and a speed reduction system. The prints are held in contact with the drum by means of the belt and are dried in one revolution of the drum.

The Pakonomy Print Dryer, Model 26W. The Pakonomy Print Dryer, shown in figure 4-2, is typical of the print dryers found in base laboratories. Let us discuss its operation as an example of dryer operation.

General procedure. To start the dryer, turn on the drive and heater switches. When the dryer is up to the proper operating temperature, prints may be placed on the apron for drying. It is best to run a few trial prints first to establish a suitable setting for production prints. Glossy prints are placed on the apron emulsion side up; matte prints, emulsion side down.

A pilot light is provided to indicate when the heater is operating. This light goes out when the heater attains the desired temperature setting. Two thermostats are provided: a control thermostat for manual setting of the required operating temperature, and a safety thermostat inside the heater unit, which prevents damage in the event of the failure of the control thermostat. The safety thermostat is preset at the factory at approximately 200° F. (94° C.), and no further adjustment is required.

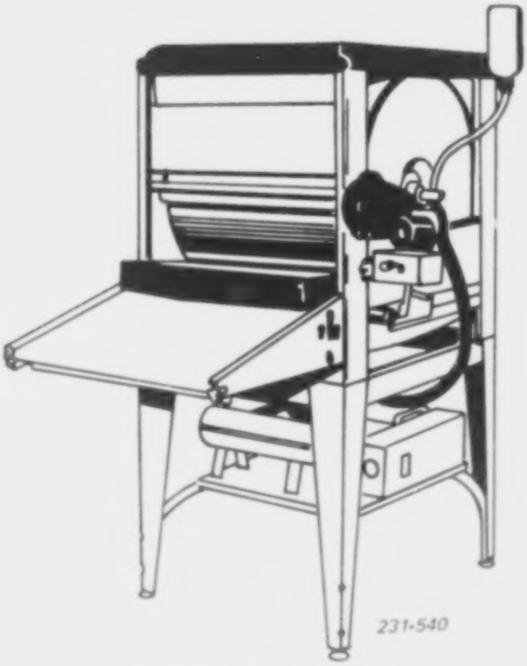


Figure 4-2. Pakonomy print dryer

For normal operation, set the control thermostat to 190° F. (88.5° C.) for the initial run. Subsequent experience will suggest variations, in conjunction with apron speed, to secure optimum performance under variables of paper weight and humidity.

The water circulating unit, containing the heater, is provided with an ON-OFF switch and a thermostatic temperature control. The motor drive unit has a similar ON-OFF switch and a rheostat speed control.

With the heater switch ON, the heating elements are on until the drum temperature reaches the level set by the control dial. The control thermostat then automatically turns the elements on and off to maintain the required temperature.

Apron tracking adjustment. Before starting up the dryer the first time, it is advisable to check out the apron tracking adjustment. Insure that the dryer is standing square and level, then proceed as follows:

(1) Turn on the drive motor switch.

(2) Set the collars on the apron guide shaft to allow a 1/4-inch (6mm) clearance for each edge of the apron.

(3) When running, the apron will slowly drift away from the tight side. Correct this drift by turning the adjusting screw on the right table arm.

(4) When the apron appears to be centered, run the dryer for an hour to see whether further fine adjustment is needed.

(5) Should the squeegee roller rub on the lever bracket, you can remedy the problem by compressing the collars on the ends of the roller to secure the necessary running clearance. Avoid excessive compression, as this may cause a flat spot in the roller.

(6) Check the apron rollers for free running. Binding rollers may cause friction and generate troublesome static.

Heat and speed settings. Many factors influence the heat and speed settings used. These include:

a. Type and brand of sensitized material to be dried.

b. How well the prints are processed.

c. Room temperature and humidity.

d. Maximum practical drying temperature for specific print material.

e. Draining and handling of prints prior to drying.

f. Your operating procedures and cleanliness, especially of the apron.

Adjust the heat and speed settings so that prints drop from the drum as they emerge from the apron with no evidence of dull spots or fleck marks. As a guideline, the following speeds are recommended (speeds are set by the rheostat control on the front of the drive unit):

a. Black-and-white single-weight, glossy—30-36 in. (76-91cm) min.

b. Black-and-white double-weight, matte—20-24 in. (51-61cm) min.

Do not attempt to use excessive speeds; otherwise, not all prints will dry adequately. Strive to maintain constant speed and temperature settings. Normally, once a suitable setting is found, it is necessary to change speed only if prints of a different weight or type are to be run.

If a print sizzles when first set against the drum, the heat setting is too high. Turn back the thermostat 5° (3° C.) at a time until prints no longer sizzle.

Stopping the dryer. To stop the dryer, first turn off the heater. Run the dryer for at least 5 minutes, and then turn off the drive motor. A badly scorched apron may result if the motor is switched off too soon. NOTE: Never turn on the heater unless the drive motor is running.

For best results, always consult the relevant technical order for the dryer that you are using.

RC Dryer. The dryer (Pako Tempro 400) shown in figure 4-3 is designed to dry resin coated or plastic based prints. It can handle prints up to 24 inches (61cm) wide. You can dry approximately 325 8 x 10 prints in one hour. The drying temperature is 225° F. (107° C.) at a speed from 7 to 42 inches (18 to 107 cm) per minute.

Controls. Speed and temperature controls are on the front left of the dryer. On the front right of the dryer is a thermometer that indicates the temperature inside of the dryer.

The maximum temperature inside the dryer is not supposed to exceed 225° F. (107° C.). If it should reach 235° F. (113° C.) the safety thermostat automatically shuts off the power to the heaters. When the temperature cools down to below 200° F. (94° C.), press the reset button and power will be restored.

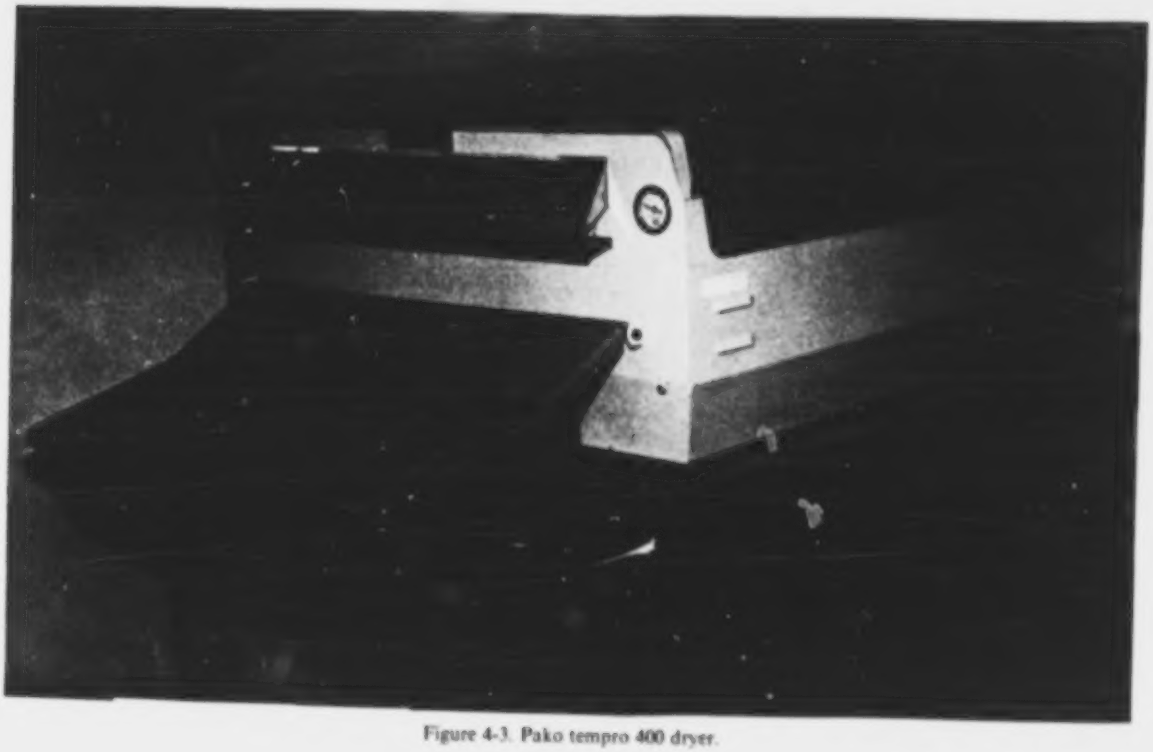


Figure 4-3. Pako tempro 400 dryer.

Opening and closing the sliding cover operates the main switch, which controls all of the electrical circuits. You should not use the temperature control as an on off switch for the heaters.

General Procedures. To start the dryer, all you have to do is close the sliding cover. Allow 15 to 20 minutes for the dryer to warm up.

Heat and speed settings. With most RC papers, you need to set the temperature control at 6.5 and the speed control at 3.5. Experience will allow you to get the best combination of heat and speed. If the temperature is too low, the prints will not dry in a single pass through the dryer. If the temperature is too high, the prints will have excessive curl. Change the speed and temperature until the prints are dry and flat as they come out of the dryer.

Operation. To dry your prints using this dryer, follow these steps.

1. Close the cover.
2. Set the speed and temperature.
3. When the temperature reaches 180° F. (83° C.) start feeding the prints in emulsion up.
4. Watch the prints through the window to be sure they are not curling. Check the prints in the receiving tray to be sure they are dry.

Standby. If the dryer is to be idle for a few minutes to an hour, you can lower the temperature to 140° F. (60° C.). This will conserve electrical power.

Shut off. When you are done drying prints, simply open the door. Wipe off the rollers with a clean, damp sponge or cloth.

Exercises (658):

Complete the following statements related to print dryer operation:

1. Matte prints should be placed emulsion side ____ on the apron.

2. Glossy prints should be placed emulsion side __________ on the apron.

3. Glossy prints are dried at a __________ rate than matte prints.

4. The pilot light on the Pakonomy dryer goes out when the heater reaches the __________ ____ __________ .

5. Electrically heated ________ is the Pakonomy Dryer's source of heat.

6. __________ rollers may cause apron friction and generate static electricity.

7. The drive motor should continue to run after the __________ has been turned off.

8. Room __________ and __________ will affect your heat and speed settings.

9. The Pako Tempro 400 dryer can dry prints up to __________ inches wide.

10. If the dryer temperature gets too high, the ______ __________ shuts off the power to the ______ .

11. __________ and __________ the cover operates the main switch.

12. Prints should be __________ and __________ when they come out of the dryer.

4-3. Mounting Prints

For exhibition, display, and handling purposes, a print is usually mounted on a stiff board that sets off the picture by a broad border and also protects the edges of the print itself against damage.

659. State principles related to print mounting and describe procedures and materials that are used to mount prints.

Mounting Principles. In preparing a print for exhibition or display, the objective is to show the print to best advantage. Simplicity is essential in doing this. Any elaborate artwork, such as colored borders or fancy lettering, often detracts from the main point of interest, which, of course, is the print image.

Prints for display purposes are generally mounted on special cardstock to make them stand out from their surroundings. The cardstock is available in various sizes, colors, textures, and weights. While no definite rules can be given, you should use a mount that compliments the print. The mount should be large enough to balance and amply support the picture, while the texture and color should lend themselves to the overall tone. (Before using colored cardstocks, try plain black or dark gray and see how well your work will stand out.)

The placement of the print on the mounting board is of utmost importance. Prints mounted at strange angles or in a corner of the mount are not generally acceptable. The prints should be placed on the board in such a manner that the borders on the sides are equal and, when possible, equal to the top border. For good balance, the bottom border should be about one-third wider than the top and sides. See figure 4-4 for the steps you can follow in placing your print.

Adhesives. The adhesives used for mounting prints are of two types: wet or dry. The liquid adhesives generally used are photo paste, glue, gum arabic, rubber cement, or the new types of pressurized spray fixatives. When you are using these wet adhesives, it is almost impossible to prevent some staining or smearing of the mounting board around the edges of the print. Furthermore, these glues often dry out and the print may loosen and peel off the mount. Therefore, you should wet mount only for temporary displays.

Dry mounting is the preferred method. For a temporary dry mount, you can use double-sided self-adhesive tape. A length of this may be applied to the top edge of the print, or shorter pieces to the four corners. The protective backing of the tape is then stripped off, and the print placed in position on the mount.

For a permanent bond, you can use pressure-sensitive adhesive sheets that require no additional equipment or heat. To use this material, you simply peel off one side of the protective sheets and apply it to the print. Then peel off the protective sheet on the other side of the material and mount the print in place.

The traditional method of dry mounting prints is done by using dry-mounting tissue, a tissue paper

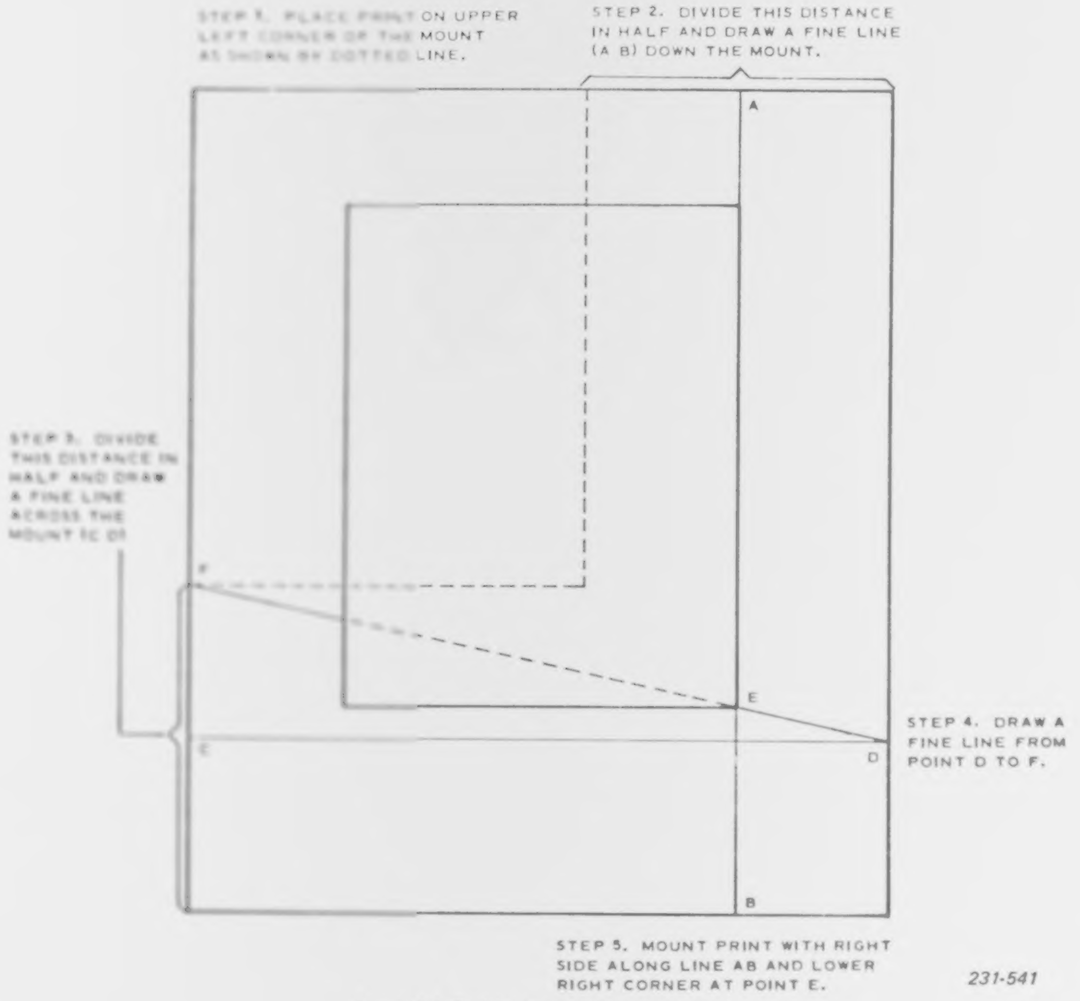

STEP 1. PLACE PRINT ON UPPER LEFT CORNER OF THE MOUNT AS SHOWN BY DOTTED LINE.
STEP 2. DIVIDE THIS DISTANCE IN HALF AND DRAW A FINE LINE (A B) DOWN THE MOUNT.
A
STEP 3. DIVIDE THIS DISTANCE IN HALF AND DRAW A FINE LINE ACROSS THE MOUNT (C D)
F
E
C
D
STEP 4. DRAW A FINE LINE FROM POINT D TO F.
B
STEP 5. MOUNT PRINT WITH RIGHT SIDE ALONG LINE AB AND LOWER RIGHT CORNER AT POINT E.
231-541

Figure 4-4. Positioning a print on a mount.

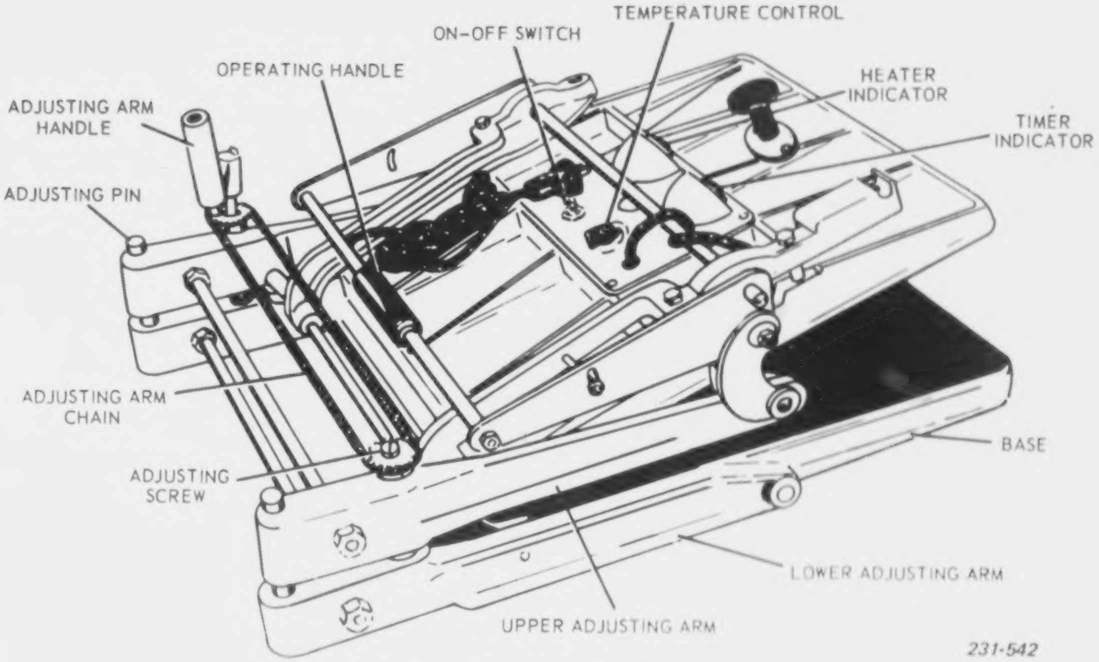


Figure 4-5. Dry mounting press.

coated on both sides with a shellac type of adhesive. The tissue is dry, thin, not sticky, and very easy to handle. Furthermore, it is odorless and chemically inert so that it will not stain a print. Being moistureproof, it will not wrinkle a print. It is well suited for either double-weight or single-weight prints; and it gives a strong, flexible, and very permanent bond between print and mount. Because the dry mounting process is clean, simple, and efficient, it is the method you will most likely be using in your work. (Dry mounting procedures are discussed further when we describe the operation of a dry mounting press.)

Exercises (659):

1. What should be your basic concern in selecting the cardstock for mounting your prints?

2. List the five steps to follow when you are positioning a print on a mounting board.

3. What are disadvantages of using a wet mount?

4. What are the primary advantages of dry mounting?

660. Explain procedures related to the operation of a dry mounting press and the process of dry mounting.

Dry Mounting Press. The dry mounting press is an efficient and simple implement for making attractively mounted photographic prints. Heat is used to fuse the dry mounting tissue between the print and the mounting surface.

Figure 4-5 shows a Type A-2 dry mounting press, which is typical of the kind available in many labs. With this type of press, both the heat and pressure that are required for mounting are provided. For dry mounting black-and-white prints, the press temperature should be set at approximately 235° F. (114° C.). For extra-heavy material, set the press at approximately 275° F. (135° C.). (For resin-coated paper, consult your instruction sheet for proper dry mounting procedures.) This type of press is equipped with indicator lights. A green light glows when the set temperature has been reached. A red light flashes "on" and "off" approximately once every second when the press is closed and provides a means for timing. Check with the applicable technical order or manufacturer's instructions for the operating procedures for your particular unit.

Mounting Steps. The dry mounting process is easy and requires few operational steps. Before doing any actual mounting, prepare the press and dry the cover sheet used to protect the print in the press. A piece of heavy paper, a medium-weight piece of cardboard with a smooth finish, or a photographic blotter works well as a cover sheet. Place the cover sheet on the pad and bring the heated platen into contact with it. Allow the platen to remain down for 1 or 2 minutes to remove all trace of moisture from the cover sheet. Follow this procedure whenever there is a possibility that the cover sheet has absorbed moisture from the air.

Place the untrimmed print face down on a table and put a piece of dry mounting tissue, slightly larger than the print, on top of it. Tack the dry mounting tissue to the print by drawing the beveled edge of the tacking iron (shown in fig. 4-6) across the tissue at several points. With the mounting tissue thus secured to the print, turn the print face up and trim it to its final size, trimming both print and tissue simultaneously. (Watch your fingers when you are trimming!)

Holding the trimmed print in the desired position on the board, tack the print to the board in at least two places. This practice will insure that the print does not move on the board when you are using the press.

Place the print and board on the pad in the press so that the print is face up. Cover the print and mount with the dry cover sheet. Apply pressure and heat by lowering the heated platen and locking it in the down position. After 10 to 20 seconds, release the pressure and remove the print. To test for permanent adhesion between the print and mount, allow the print to cool and then slightly bend the mount backward away from the print. If the print does not adhere to the mount, another application of heat is necessary.

The amount of heat applied to a print is important. Insufficient heat does not adequately fuse the adhesive to the print and to the mount, and the print may peel away from the mount. Too much heat melts the adhesive and allows the paper of the print and the paper of the mount to absorb it. As a result, the bonding between the print and tissue and between the mount and tissue is not good enough to hold the print. Since the mounting time varies according to the conditions and materials, you will need to experiment to achieve ideal bonding.

To mount prints larger than the platen, make several impressions by moving the print so that each portion receives an equal application of heat and pressure.

NOTE: Remember proper safety precautions when you mount. Tacking irons and presses generate high temperatures, which can cause serious burns. Be careful when you use these tools and do not leave them unattended. When you are finished, unplug the equipment and leave a "HOT" sign to warn your fellow workers of possible danger. You will also be using paper trimmers. Remember to lock down the trimmer blade when you are finished.

Exercises (660):

1. What is indicated when the green light on the A-2 dry mounting press glows?

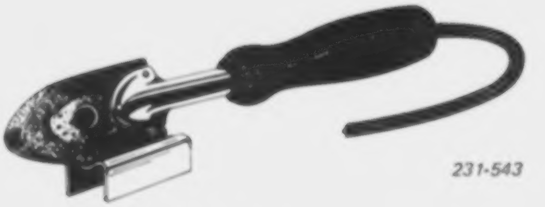


Figure 4-6. Tacking iron on stand.

2. What temperature is used for mounting single-weight black-and-white prints?

3. Describe how to prepare a print for dry mounting.

4. Why is it important to use the right amount of heat when you dry mount?

4-4. Captions and Stamping

In another volume we discussed captions and stamping as they pertained to records disposition. Now that the prints have been made, it would do well to review this and add a few things.

661. Explain procedures of captioning and stamping photographs.

Captions. AFR 95-4 tells us what must be included in a caption and how to complete a caption. Air Force Forms 397 and 398 must be used to record caption data. No other forms may be used. The caption should provide at least:

(1) Date of exposure, exposing unit, name of photographer, and location.

(2) Photo identification number.

(3) Classification, if applicable, downgrading instructions, and classification authority.

(4) Description of subject matter that includes a full identification of project or event and the first name, middle initial, last name, and grade of principle subject(s).

(5) Explanation of what happened, why it happened, who was involved, and where and when it happened.

This information is not stamped onto the print. Rather it is recorded on the AF Form 397 and then left in the negative envelope.

Ink Stamping. All of the photographic prints of record material must have certain information attached in such a manner that it becomes a permanent part of the photograph. The information, as a minimum must include:

(1) The original identification number.
(2) Classification if applicable.

You can make this information a permanent part of the photo by using friskets and by typing or ink stamping on the back of the prints.

The easiest method is to use an ink-stamping device. The information that you put on the print should conform to the following example:

OFFICIAL US AIR FORCE PHOTO
1369 Photo Sq (AAVS) (MAC)
1-78-1369 PS (Unclas)

Some organizations include the photographer's name.

The ink-stamping device may be a fairly elaborate, electrical, continuous device or, perhaps, only a hand-held stamp. The most important part of stamping is not the device but rather the ink.

If you are using fiber-base paper, the type of ink is not terribly important. However, if you need to stamp RC paper you must use an alcohol-based ink. This is because regular ink will not dry fast enough nor adhere to RC paper. It will run and smear, generally making a terrible mess.

After you have stamped the prints, stack them back to back or face to face. Never stack them back to face because you run the risk of the ink smearing the face of the print.

Exercises (661):

1. Which Air Force regulation governs captioning photographic materials?

2. What is the easiest method of making written information a permanent part of the photograph?

3. Why must you use fast drying ink to stamp RC paper?

4-5. Operator Maintenance

By now you must have guessed that operator maintenance is a very important part of your every day tasks and duties. Your finishing equipment is just as important as any other photographic equipment. Don't neglect it just because it is in the finishing room and is not seen by very many people.

662. Specify principles and techniques related to operator maintenance of finishing equipment.

Once again, as in other areas, cleanliness is the first step in finishing equipment operator maintenance. Washers, dryers, trimmers, and mounters must be kept clean. You must also check for loose fittings, nuts, bolts, screws. Look for frayed electrical cords and connections.

Washers. Use a clean wet sponge to clean the exterior of a washer.

The water tank of the washer should be cleaned daily. Use soap and scrub the tank vigorously to ensure that no chemical deposits can be left in the tank. It will also reduce the possibility of calcium deposits being left in the water tank. Every week you should remove the drum and give it a very thorough cleaning. A 10 percent solution of sodium nitrate is suitable for cleaning the drum. Scrub it vigorously also. Do not use abrasives to clean the stainless steel components.

Dryers. Check belt dryers for obvious dirt, dust, and chemical spills. Clean and polish the drum according to the TO. Look at a dried print held obliquely to the light. Lines in the print indicate scratches on the drum. Pock marks on the print mean you have dirt and dust on the apron, dirty predrying solutions, or you have allowed water to drip on the print just before you fed it onto the drum.

RC dryers such as the Pako Tempro 400 need to be cleaned inside and out. Clean the entrance rollers. Check for flat spots on the rollers and have them replaced as necessary. Flat spots are caused by leaving the cover shut while the dryer is not working. This allows the rollers to stay in contact with each other. Wipe the transport rods with a clean damp sponge.

Mounting Press. Check for working parts such as the handles, indicator lights, hinges, tension adjustments, etc. Those things that you can fix or replace, do so. Those you cannot, have maintenance people repair.

Clean the heating platen weekly. The best maintenance here is to prevent mounting tissue from sticking to the platen by using a cover sheet.

If you must use a cleaning solution, remove the pad first. While you have the pad out, clean it with a stiff brush.

General Procedures. In addition to the obvious benefits of clean equipment, your cleaning habits will give you at least one more benefit. That is, as you clean the equipment, you can look for other malfunctions. Fix those that you can; identify and have fixed those that you cannot.

Exercises (662):

1. How often should you clean the tank of a print washer?

2. Lines on a print dried on a drum dryer indicate what condition of the drum?

3. Dirt and dust on a dryer apron will cause what defect on the print?

4. How can you prevent the entrance rollers on the RC dryer from being worn flat?

5. How do you prevent mounting tissue from being stuck to the heating platen?

Principles of Color Photography

COLOR ADDS a realistic dimension to photographic work. At one time color was a difficult medium to work with, requiring specialized cameras and processing only by the film's manufacturer. Now color materials have been greatly improved to a point that color is far more popular than black-and-white. Air Force wide, color photography is important for slide briefings, documentation, scientific studies, reconnaissance and displays. In this chapter we will discuss the basic principles of color photography and how to expose, process, duplicate, and finish transparencies.

5-1. Principles of Color Photography

The basics of color photography require that you understand the nature of light and the additive and subtractive processes, the two systems that can produce color. Each of these subjects is discussed in this section.

663. Identify basic principles of color photography.

Light. Without light, color does not exist. Light is defined as that portion of the electromagnetic spectrum that affects the sensory organs of the eye and produces the sensation of vision. The visible portion of the spectrum is the part primarily responsible for photographic exposure, but infrared (IR) and ultraviolet (UV) also play a significant part in the field of photography. Infrared, untraviolet, and visible light make up what is known as the optical spectrum. Because infrared and ultraviolet radiations obey the laws of optics, they have special applications in the area of photographic research. They are also used extensively in investigative and medical research photography.

The visible light portion of the electromagnetic spectrum (see fig. 5-1) extends approximately 400 to 700 nanometers in range. (A nanometer is a metric measurement equal to 1 billionth of a meter.) The radiations at the 400 nm end of the spectrum appear blue to the eye; those radiations around 500 nm appear predominantly green; and those in the 700 nm region of the spectrum appear red. Infrared and ultraviolet radiations fall into the spectrum immediately above and below the range of visible radiations. Infrared falls immediately above the 700 nm portion of the spectrum and ultraviolet immediately below the 400 nm portion.

"White light" is a term used to identify the visible spectrum when all the wavelengths, from 400 nm to 700 nm, are present in nearly equal amounts. However, due to the adaptability of the eye and various human and psychological reasons, it is impossible to establish a standard for white light. For example, indoor lighting and sunlight both appear to be white.

Why do they both appear white when it is a known fact that they do not contain the same amounts of visible radiation?

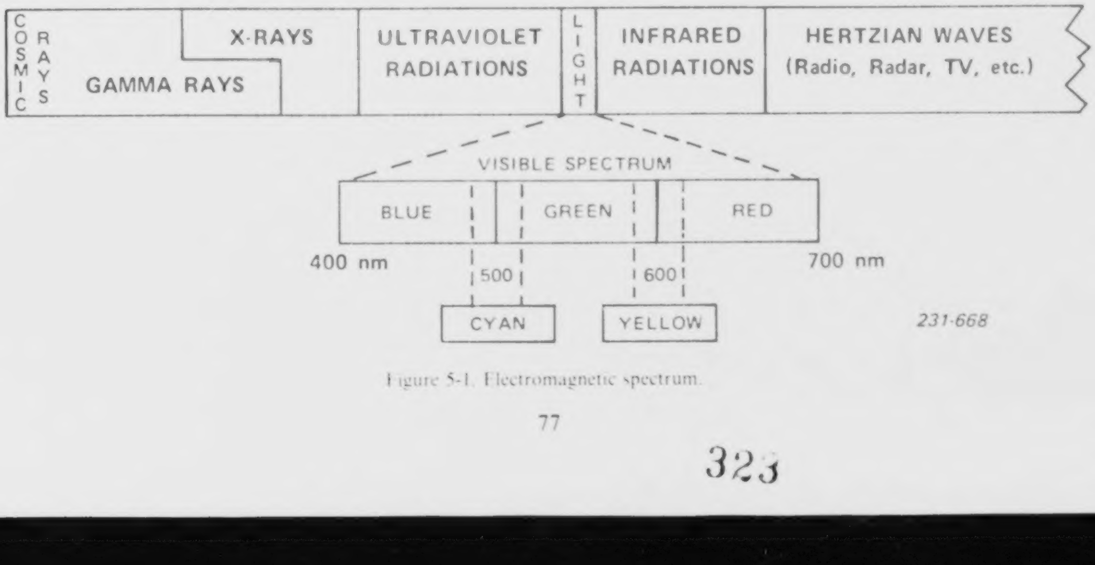


Figure 5-1. Electromagnetic spectrum.

They both appear white because the receptors in the eye, which are sensitive to red, green, and blue wavelengths of light, are capable of adapting their sensitivity to compensate for imbalances in wavelength proportions. For example, sunlight has a higher percentage of blue and green wavelengths and is relatively deficient in the red region of the spectrum. As a result, the red receptor increases in sensitivity until there is the necessary balance of wavelength impulses reaching the brain and the viewer perceives the sensation of white light.

While the individual receptors have the capability of adjusting in sensitivity, the eye itself is not selective in regard to individual wavelengths. In order for the eye to see a single wavelength, it must be isolated and presented alone. For example, the eye cannot be selectively turned to red, green, or blue radiations when they are presented in combination.

It should be noted, however, that it is possible for the eye to visualize colors not present in the spectrum. If equal amounts of red and blue wavelengths strike the eye, we see a purplish or magenta color. Because red and blue are at opposite ends, magenta does not exist in the visible spectrum. Actually, we see magenta because the surface is reflecting equal amounts of incident red and blue radiations and absorbing the green. Yellow is another example of this phenomenon. Yellow occupies only a small part of the visible spectrum, approximately 575 to 590 nanometers. If only yellow radiations were reflected to the eye, the reflecting surface would be so dark as to appear black. Most yellow, seen by the eye, is the result of the surface absorbing incident blue radiations and reflecting the red and green.

Evaluation of Color. To evaluate color quality effectively, we need to know more about how color is produced. Some of the more important methods of color production are absorption, selective reflection, scattering, interference, dispersion, and fluorescence.

Most color occurs when illumination, falling on the subject, is not evenly absorbed at all wavelengths. If the subject did absorb all wavelengths equally, we would have to illuminate the subject with colored light in order to see color. Thus, under normal conditions, the color of the subject is dependent on its absorption and reflection characteristics in relation to the various wavelengths present in the illumination.

Selective reflection is a characteristic displayed by certain metals. Gold, copper, and brass are some of the metals that exhibit these qualities. Specular reflections from other metals tend to be white. The selective reflection of red and yellow light, by the front surface of gold metal, gives it its characteristic color.

Variations in atmospheric density, airborne particles, such as dust, droplets of water, and ice crystals, have the ability to affect the shorter wavelengths in the spectrum to a greater degree. When light enters the atmosphere, the shorter wavelengths of light are scattered more than longer wavelengths. This alters the color quality of the incident light. Haze is the result of light scattered by the atmosphere.

Have you ever noticed the patterns of color produced by oil on the surface of the water and wondered what caused them? They are produced by lightwave interference from two surfaces spaced a few millimicrons apart. When light is reflected from these two surfaces, a portion of the reflected light will be cancelled when the two light waves meet—one reflected from each surface. This interference produces the color you see.

The color patterns, formed by light-wave interference, are known as Newton's rings. Under certain circumstances, Newton rings can present problems when working with color materials. They may occur if you are printing color using a glass negative carrier. The irregular contact between the glass and the negative surface may produce interference effects. This effect may also occur in glass-mounted slides. The use of a glassless carrier and a special glass for the slide mounts can remedy these problems.

The rainbow is a natural example of dispersion. For a given medium, as the wavelength of light increases, the angle of refraction decreases. Light waves, striking the droplets of water in the atmosphere, are refracted according to wavelength into the colors of the spectrum. Dispersion of these wavelengths creates one of nature's more colorful spectacles—the rainbow. A prism may also be used to disperse light. (See fig. 5-2.)

Color can also be produced through fluorescence. Fluorescence is the ability of a material to absorb radiations of one wavelength and reradiate them at another, usually longer, wavelength. This is what takes place in the fluorescent lamp. The fluorescent lamp is really a mercury vapor lamp that has been coated with a powder that fluoresces when bombarded with ultraviolet radiation. When power is applied to the lamp, the mercury emits ultraviolet radiations absorbed by the fluorescent powder and reradiated as visible light.

When we assign a color to anything, we are attempting to describe certain characteristics of the object under normal conditions. We must remember that these characteristics vary with changes in spectral quality and intensity of illumination. Since it is impossible to specify color under all conditions of illumination, most color is identified when viewed under normal daylight or tungsten conditions.

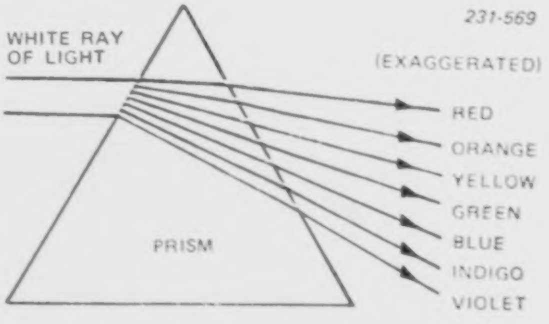


Figure 5-2. Dispersion.

Three terms used to help identify color are hue, brightness, and saturation. They are used as tools to assist in color communications. If we are to be more explicit in color communication, we should know something about these terms.

Hue is a term used to assign a general color to the subject. If we say the subject is red or yellow, we are identifying the hue. However, there are as many shades as wavelengths in that portion of the spectrum. If we assign a hue only, we are less than specific in color identification.

To further describe a color, we might say that it is light green or dark red. This is an attempt to describe the brightness of the color and is some measure of its absorption and reflection characteristics.

Saturation is used to describe the purity of a color. If the color is pure, it could be called a brilliant color, as a brilliant red. Impure colors appear dull. Saturation is determined by comparing the color to a neutral gray of the same brightness.

Why Colors Can Be Photographed. Regardless of the process you use to obtain your color product, the starting point is the same as that developed by James Clerk Maxwell. He demonstrated that a subject could be photographed and reproduced in its natural colors. Maxwell illustrated his color process by placing in separate projectors three positive transparencies of a still-life subject he photographed. He inserted a primary color filter in the light path of each projector; and the red, green, and blue images superimposed on a screen. Maxwell's projected color image was not particularly good, but the experiment did soundly demonstrate an important color principle.

Maxwell's demonstration, made to a group of scientists in 1861, was the forerunner of all present color processes. He made the original exposure by using liquid filters to transmit the three basic colors of light. A negative was made through each of his red, green, and blue filters. This set of three negatives (which were black and white) represented in silver density the ratio of red, green, and blue in the original subject. Each of the negatives he then printed on film to give a positive transparency.

He projected the three positives through the same primary colored filters used in making the original negatives. When he projected all three positives on the same screen and in register, one on top of the other, the result was a color reproduction of the original subject matter. This process is graphically shown in figure 5-3, where you see how the three color negatives of a red ball are made through the three filters (part A). Follow the green-filter projection and notice that the resulting silver density represents the quantity of green reflected from the red ball. The quantity is, of course, zero; therefore, a background exposure is made, but no exposure is made for the ball.

When the negative is reversed to a positive (part B of fig. 5-3), the background becomes clear and the ball is black. If this positive is projected through a green filter, it is obvious that no green light will project to the screen in the position occupied by the ball. Since the ball is not green, this is entirely correct. With just

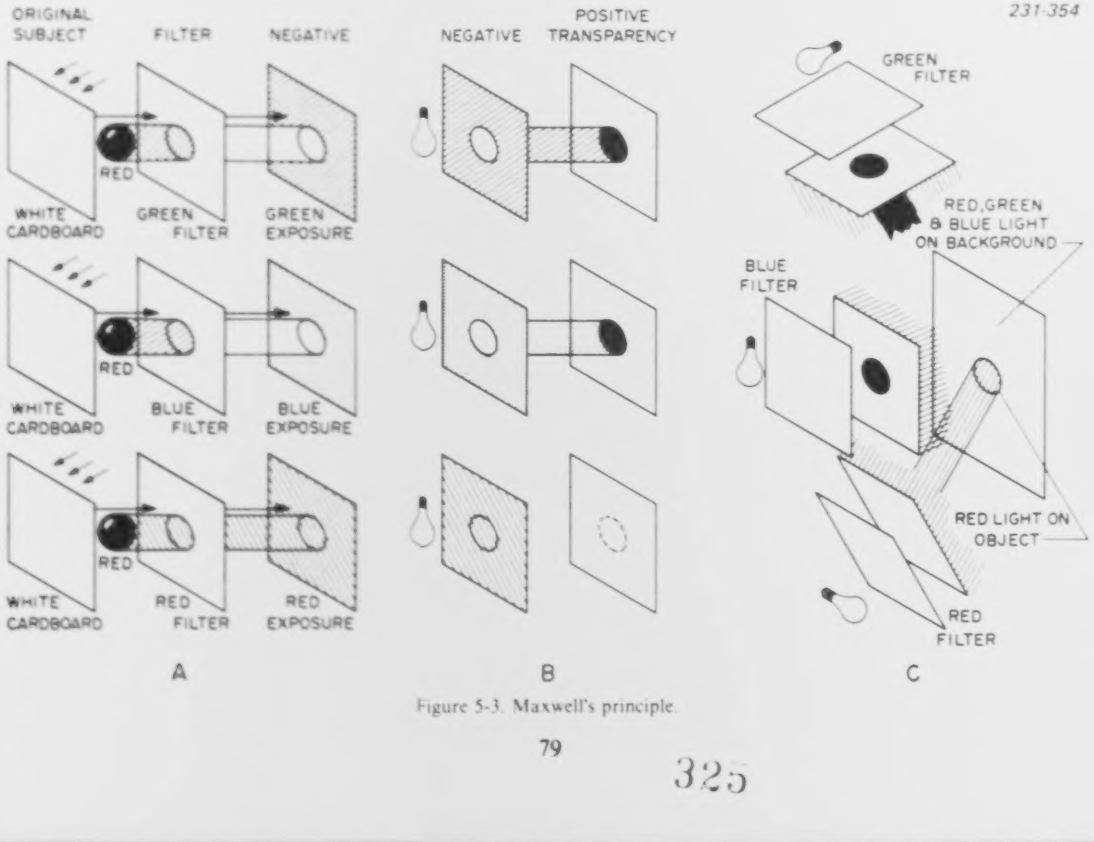


Figure 5-3. Maxwell's principle.

the green filter positive, the projection is a green background with a black ball. Using all three positives (part C of fig. 5-3), the background projects white, which is the sum of all three primary colors. The ball image projects red, because only red light is allowed to fall on the area of the screen.

One outstanding deficiency is immediately apparent when considering Maxwell's demonstration, and that is its lack of permanence. A color picture could be projected on a screen, but that was all. This was not a photograph that could be mounted in a picture frame or placed in an album. Commercial use of Maxwell's discoveries had to wait for a manufacturing process that could use their possibilities.

Exercise (663):

1. State basic principles of color photography by completing the following statements:
   a. Without __________ color does not exist.

   b. The optical spectrum is made up of __________ light, plus __________ and __________ .

   c. Visible light runs from __________ to __________ nanometers.

   d. Due to eye __________ both indoor and daylight illumination may appear white.

   e. Equal amounts of blue and red light produce __________ .

   f. The color of an object is determined by its __________ and __________ characteristics.

   g. Selective reflection is a characteristic displayed by __________ .

   h. Newton rings are caused by __________ __________ .

   i. The rainbow is caused by __________ .

   j. __________ material absorbs radiation at one wavelength and re-radiates it at another.

   k. Impure color lacks __________ .

   l. Maxwell's demonstration used the three __________ colors.

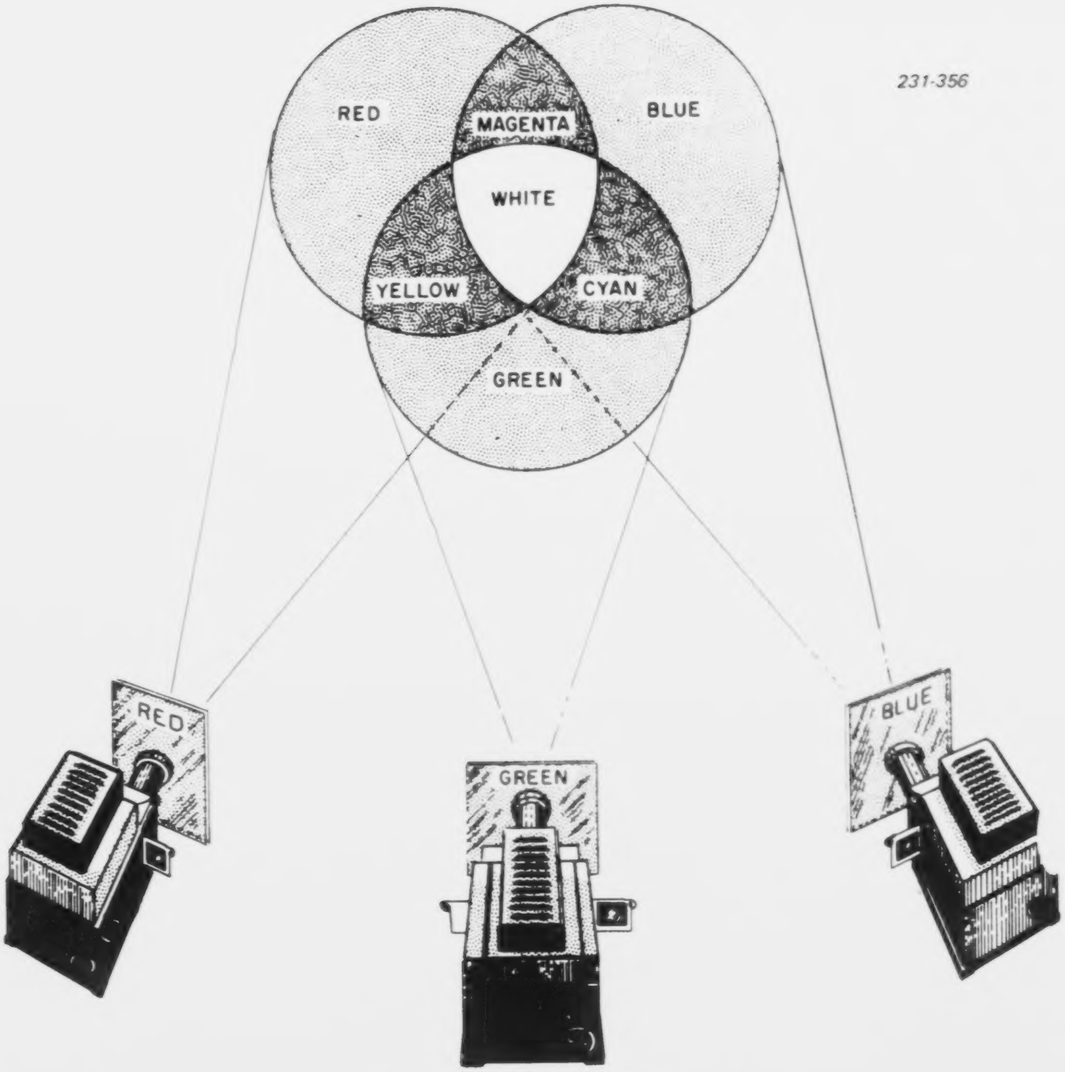
664. Specify principles of the additive process of color photography.

The Additive Color Process. Exposure of color film, and to a more limited degree color printing paper, applies the principles of the additive color process. The additive process, applying the principles developed by Maxwell, uses the primary colors of blue, green, and red.

When equal parts of blue, green, and red light are projected from separate projectors and are partially superimposed on a screen, you see in the area of overlap of all three colors, white, as shown in figure 5-4. The area of overlap between the blue and green light produces cyan (blue green), the area of overlap of the red and blue light produces magenta, and the overlap of the red and green light produces yellow. Almost any desired color match can be produced by varying the amount of one of the two colors used for producing that color. For example, if you have equal proportions of red and green, the result is yellow; by increasing the amount of red, the result is orange. Since matching a wide range of colors with red, green, and blue light involves addition of the colored light, the primary colors are often identified further as the additive primaries.

In color photography, the three colors produced by mixtures of additive primaries in pairs are of particular importance. These colors—cyan, magenta, and yellow—are known as the subtractive primaries. Since each represents white light minus one of the additive primaries, the subtractive primaries are the complements of the additive primaries. For example, cyan and red light blend together to give white light. Similarly, magenta is complementary to green, and yellow is complementary to blue.

At this point, refer to figure 5-5 and study the illustration of the color star. Remember which colors are the additive primaries (blue, green, and red) and notice that the subtractive primary colors between any two of the additive primaries are mixtures of these two primary colors. Also, notice the colors that are directly opposite to each other in this star; these colors are complementary to each other.



231-356

Figure 5-4. Additive color system.

Although the original photographic record on color film uses the additive primary colors, these are not suitable for the final color product. This is because any combination of primary colors over one light source results in neutral density. A transparency, for example, must be viewable when you use only one white light source. It is the subtractive process, discussed in the next objective, that makes the "final product" possible.

Exercise (664):

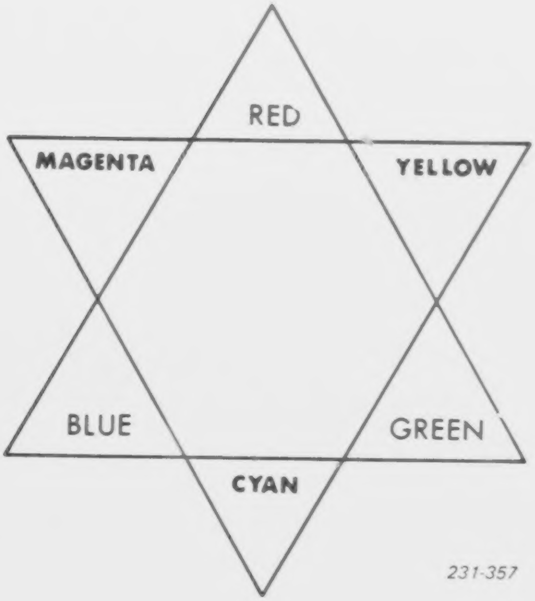
1. Complete the following statements regarding the additive process.
   a. The additive color process requires __________ separate light sources.
   b. A combination of equal amounts of red and green light produces __________ light.
   c. The subtractive primaries are __________, __________, and __________.
   d. Yellow is the complement of __________ light.

665. Specify principles of the subtractive process principle of color photography.

The Subtractive Color Process. In the additive color process where three projectors were used (one lens was covered with a red filter, one with a green filter, and one with a blue filter), we were able to produce any desired color. Theoretically, any filter transmits light of its own color and absorbs all other colors. The amount of absorption depends upon the density of the filter. Therefore, we could not place all three filters over a single light source. To a certain extent, the filters are mutually exclusive; that is, none of them transmits light passed by either one of the other two. Consequently, any two of the filters used in combination in front of a single light source absorb all of the light.

Since a filter of any of the additive primary colors transmits only that one primary color, the subtractive primary colors are used as filters in the structure of color materials. This makes it possible to transmit any two of the additive primary colors and subtract the third.

NOTE: The term subtractive primary color has the same meaning as secondary color that was used when we discussed filters. The colors yellow, cyan, and magenta can be called either secondary colors or subtractive primaries.



RED + GREEN = YELLOW
RED + BLUE = MAGENTA
BLUE + GREEN = CYAN

Figure 5-5. Color star.

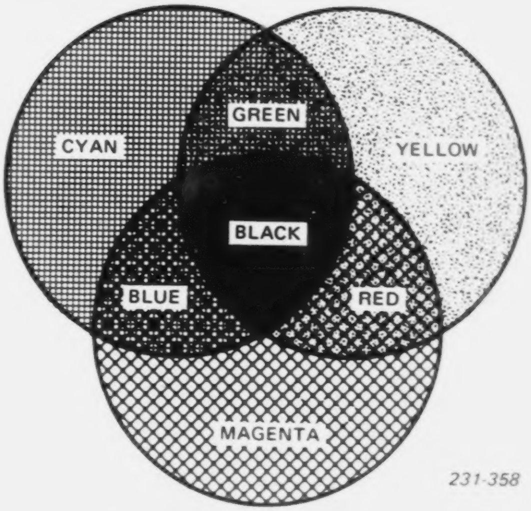


Figure 5-6. Subtractive color system.

A cyan filter transmits blue and green light, but absorbs red light; hence, it subtracts red from white light. Similarly, a magenta filter (which transmits red and blue) functions by subtracting green from white light.

Since each of the subtractive primary filters transmits approximately two-thirds of the visible spectrum, we can superimpose any two of them over a single light source to produce other colors. Refer to figure 5-6 for an illustration of the principle of the subtractive color process. Notice that the combination of any pair of the subtractive primary colors in equal densities produces one of the additive primary colors. For example, a yellow filter transmits red and green and absorbs blue, and a magenta filter transmits red and blue and subtracts green from the light source. When these two filters are used over a single light source, the one color that is transmitted by both magenta and yellow is red. Therefore, yellow plus magenta produces red. In the same manner, when yellow and cyan are used in combination, the one color that is transmitted by both filters is green; since yellow transmits red and green, and cyan transmits blue and green. Cyan plus magenta produces blue, because blue is transmitted by both filters. Where all three filters overlap in the center, all of the light is absorbed, and the result is black.

By varying the density of either one of the filters, any desired change in the color produced can be brought about. For example, to change the appearance of red to make it an orange red, increase the amount of yellow; in other words, decrease the amount of magenta.

Exercise (665):

1. Complete the following statments on the subtractive principles.

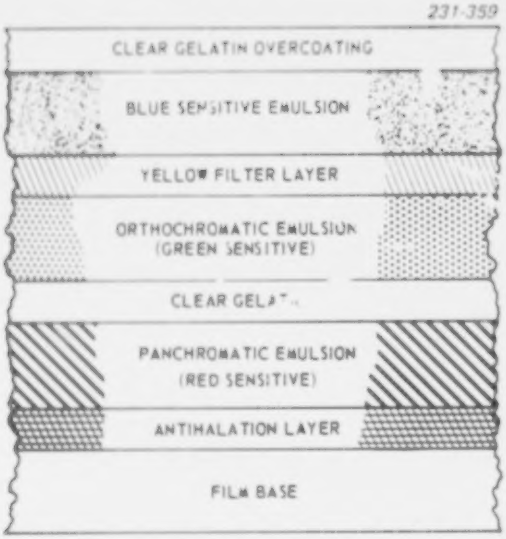
a. A primary filter transmits ____________ color of light and absorbs ____________

b. A combination of cyan and magenta filters will pass ____________ light.

c. A cyan filter passes ____________ and ____________ light.

d. Three secondary filters over one light source would pass ____________ light.

e. Red can be produced by passing light through a combination of ____________ and ____________ filters.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CLEAR GELATIN OVERCOATING
BLUE SENSITIVE EMULSION
YELLOW FILTER LAYER
ORTHOCHROMATIC EMULSION (GREEN SENSITIVE)
CLEAR GELAT
PANCHROMATIC EMULSION (RED SENSITIVE)
ANTIHALATION LAYER
FILM BASE

Undeveloped Film

Figure 5-7. Cross section of color film.

5-2. Color Film Characteristics

Color films fall into two basic types: reversal and negative. Reversal color films, identified by the suffix "chrome" (Kodachrome, Ektachrome, Agfachrome, Fujichrome, etc.), are processed to a positive transparency (slide). The image can then be projected on a screen or viewed on a light box. Negative films, identified by the suffix "color" (Vericolor, Agfacolor, Fujicolor, etc.), are processed to a negative that then is printed to make prints. Within each category of film you can obtain different sizes (35mm, 120, 4x5, 8x10, etc.) and films balanced for either daylight or tungsten light sources. Which you choose depends on your mission requirements. In this section we briefly discuss the characteristics of color films.

666. Complete statements on the characteristics of color film.

Structure of Color Film. Today, color materials consist of three thin coats of emulsion on a single film base. Each emulsion is separated from the next by an extremely thin interlayer of gelatin. Such a structure is known as multilayer film.

Figure 5-7 shows a cross section of a typical color film. Start at the top and work down the diagram. An antiabrasion coating protects the film from minor abrasions. The next layer is a blue-sensitive emulsion layer. The next layer is a built-in yellow filter made of colloidal silver. The purpose of the filter is to absorb any excess blue that was not recorded in the top emulsion layer. This prevents any recording of blue in the middle emulsion layer. The middle emulsion layer is orthochromatic (sensitive to green and blue) and its purpose is to record the green light. The bottom emulsion layer is panchromatic with a low sensitivity to green. Since blue and green have been recorded in the first two layers, the bottom layer is to record red.

In effect then, a sheet of color film is made up of three separate emulsion layers, each layer is designed to record only one of the additive primary colors of light. Secondary colors, such as yellow, are recorded in the two layers that form to make up the color (ex. green and red for yellow). White light is recorded in all three levels.

Color Balance and the Quality of Illumination. The two major divisions of color films are based upon the quality of the light to which the film is to be exposed—daylight or tungsten. To distinguish between daylight and various artificial light sources, we commonly refer to their differences in terms of color temperature. Remember, however, that color temperature refers to the color of light as seen by a human observer with normal eyesight. There is often a great difference between the effect of color as we see it and its actual photographic effect.

A person becomes accustomed to the artificial illumination in a room, and the light appears to be white. The same room illuminated with daylight likewise seems to be illuminated with white light. However, if you turn on a tungsten lamp in a room that is illuminated by daylight, the tungsten light appears to have a yellowish cast. That which appears to be white may not be white, since the human eye is a poor measuring tool to determine the color quality of light. Thus, we need some method of measuring the color of what appears to be white light. One such method of measurement is the color temperature scale, expressed as degrees Kelvin—the temperature to which a black body radiator must be heated in order to emit light equal to a source such as tungsten lamps, the sun, etc. The scale starts at —273° Celsius (absolute zero), which is designated as zero Kelvin. The scale has become universal in the measurement of color temperature.

All tungsten or daylight sources are not at the same color temperature. Table 5-1 lists the commonly used light sources and their approximate color temperatures.

From your experience with the film characteristics of black-and-white film, you probably recall that the effective film speed often changed when you switched from daylight to tungsten light. The reason for this change was the difference in the spectral quality or the color content of the light. A change in film speed in black-and-white film usually compensates for a radical change in light quality, but this is not the case with color film; here you must consider color temperature. Color film is in correct balance for only one type of light and should be used under specific light conditions. If these conditions change, then the colors you photograph appear degraded or out of balance. Normally, each manufacturer makes at least two types of color film—one to be used under tungsten light and the other to be used under daylight conditions.

A knowledge of color temperature is valuable to you; however, the Kelvin rating of a light source is not the only factor to consider. For example, two light sources, a tungsten and a fluorescent, may be rated as having the same color temperature, but their effect upon color film may vary considerably because of differences in their spectral distribution qualities. For the same basic reason, the selection of a filter for proper balance cannot always be predicted on the basis of its effect upon color temperature alone, as you will discover by following the manufacturer's recommendations and by making tests of your own.

Daylight Film. Daylight color film is balanced at 5400 K. This means that because of the high blue content of a light with this color temperature, the film is made with a relatively lower sensitivity in the blue record emulsion and with a higher sensitivity in the red record emulsion. Consequently, the excessive blue is minimized, and all reds are strengthened in the final transparency. As a consequence the film must be exposed to predominantly blue light sources like daylight or electronic flash.

When daylight film is exposed to light with a preponderance of red, like tungsten lighting, this excess red degrades all colors, and the transparency takes on a reddish cast. Essentially the same effect is obtained by exposing daylight film just after sunrise or just before sunset. You have probably noticed the predominantly red light at these times even though the eye is a poor judge of color. The opposite, or a bluish cast, commonly appears in various winter snow scenes. As a matter of fact, the shadow are definitely blue in any outdoor picture, because they are illuminated by sky rather than by sunlight. Skylight is largely blue because the short wavelengths of blue light are easily scattered by atmospheric dust and haze. This, then, is the light that illuminates shadow areas.

TABLE 5-1
APPROXIMATE COLOR TEMPERATURE
OF COMMONLY USED LIGHT SOURCES

231-696

LIGHT SOURCE	DEGREES KELVIN
Tungsten House Lamps	2670 - 2810
Lamps for Color Photography	3200
Photoflood Lamps	3400
White Fluorescent Lamps	3500
Clear Flashlamps	3800
Photoflash "228" or "58"	5400
Daylight (Standard)	5400
Average 10 A.M. to 3 P.M. Sunlight	6000 - 6200
Daylight Fluorescent Lamps	6500
Electronic Flashtubes	5800 - 7000
Overcast Sky	6800
Clear Blue Sky	12,000 and up

Off-color transparencies and prints are not necessarily poor. Take a look at the color illustrations in any photographic magazine. Many top photographers deliberately use light of the wrong color temperature to shoot pictures. A reddish cast produces a warm tone, while an excess of blue is cold. Of course, these are special effects designed to create a particular mood.

Tungsten Film. As might be expected, film manufacturers also produce color materials that are designed for use under tungsten illumination. These emulsions are specifically color balanced for illumination that measures either 3200 K (tungsten). Tungsten lighting is rich in red; therefore, the tungsten type of color films are made with a pronounced sensitivity to blue in order to compensate for the lack of blue in this kind of illumination. This is the reason why, when you examine a roll of tungsten transparency film exposed in daylight, the colors appear to have an overall bluish cast. By using the appropriate conversion filter, you can use tungsten film in daylight and get satisfactory results.

It is important to determine the exact tungsten rating of the illumination so that you can choose the appropriate filters that may be necessary. You also should know that the color temperature of a lighting source can change with time and with line voltage fluctuations. For example, many tungsten bulbs designed for photographic use are only guaranteed to put out a particular temperature for a couple of hours. In addition, a line voltage change of 1 volt will change the color temperature by 10 K in the direction of the change. Therefore a 10-volt increase would increase color temperature by 100.

NOTE: While not covered in this CDC, there are color temperature meters for measuring the color temperature of any light source. This type of meter is invaluable in color photography.

Exercise (666):

1. Complete statements on the characteristics of color film.
   a. Color films have ________ emulsion layers.
   b. The middle emulsion in color film is designed to record ________ light.
   c. A ________ colloidal silver layer is found between the ________ and ________ emulsion layers of color film.
   d. The bottom emulsion layer of color film is a ________ type film that is designed to record ________ light.
   e. Cyan would be recorded in the ________ and ________ emulsion layers.
   f. Tungsten household lamps would be richer in ________ light than tungsten lamps designed for color photography.
   g. Daylight is rich in ________ light.
   h. Daylight color film exposed under tungsten light would give the images a heavy ________ cast.
   i. Tungsten film is designed for light sources that are rich in ________ light.
   j. If the line voltage on a 3200 K lamp went up 20 volts, the Kelvin temperature would change to ________

667. State the procedures for the care and storage of color film.

Care of Color Materials. Much of our discussion about the care, storage, and handling of black-and-white materials applies equally well to color materials. As you probably know from your experience in buying color film, the cost of color materials and processing is almost three times the cost of using black-and-white films. You can therefore appreciate that the Air Force has a substantial overall investment in color materials.

It is extremely important that any changes in ~~either~~ the length, width, or thickness of color materials be avoided because of their multilayer structure. As a rule, by maintaining control over the relative humidity (RH) content and temperature of a properly constructed film storage area, you can protect color materials from environments that cause these changes. As is the case with black-and-white films, keep the relative humidity of the storage facility at 40 to 50 percent. This is particularly important with materials which have been exposed or processed, for dye changes will result because of high humidity.

Color materials require low temperatures, as well as controlled humidity conditions, in order to preserve the initial film speed and to maintain color balance. To assure high quality, sealed containers of most kinds of color film can be stored safely for a period of several months at a temperature of 55° F (13° C) or less. For periods longer than 6 months, it is customary to store color materials at 0° to −10° F (−18° to −23° C).

NOTE: For good results it is necessary to allow the material to warm up to working temperatures prior to use.

In addition to heat and humidity, color materials should be guarded against contamination of all kinds. Film and other materials should never be stored near chemicals or any other source of vapors. Such vapors can have permanent effect on the color quality of your materials.

Exercises (667):

1. Color film should be stored in an environment which has what range of relative humidity?

2. What should be the temperature for long-term storage of color film?

3. What is likely to happen to film that is not properly stored?

4. Should color film be stored near photo chemicals? Why?

5-3. Expose Color Film

In contrast with the problems inherent in earlier color processes, present-day color films are highly standardized and effective. Even so, you must control your product if you are to obtain consistently good results under varying conditions. In this section we will cover a few points that you should remember in exposing color films.

668. State the principles and techniques of exposing reversal color film.

Exposing Reversal Color Film. Unlike panchromatic black-and-white films, color emulsions accurately reproduce a much narrower range of brightness values. Normally a scene's contrast cannot be greater than 3:1 to hold both the shadows and highlights. This calls upon the photographer to use supplementary lighting for both indoor and outdoor work to keep contrast low. This is particularly true with reversal films. The reversal process uses up all of the sensitive silver halides in order to obtain the final positive image. There is little room for error and exposures must normally be within one-half f stop of perfect in order to guarantee top quality results.

NOTE: Prove this to yourself by picking a typical outdoor scene and making an exposure test with the color reversal film that you are using. Bracket your exposures from three under through three over in half-stop increments. Such a test will give you a good idea of the latitude of the film you are using.

Figure 5-8 illustrates, in a general way, the influence that narrow film latitude has on the reproduction of a scene when you are using reversal film. For purposes of simplicity, consider each pair of the three views by its respective letter as cross sections of color film. In each case, the upper cross section represents the results of the film's initial exposure and its first development. Imagine that the original subject was illuminated by a predominantly red light such as you would find in a vivid sunset. Consider the shadows, halftones, as well as highlights, as different densities of the same color. Normally, color material can record more shades of brightness values than figure 5-8 shows. The lower cross section represents the film after it has been through the color developer. In each view, the exposed silver halides are shown in black, whereas portions of the emulsions that remain blank are not affected by light.

With a normal exposure, about one-half of the silver halides are affected (see A of fig. 5-8). Note that the film reproduction of the subject would record the same range of brightness values as the original scene. Compare the scene results of the normal exposure with those of overexposure and underexposure. The former, shown in B, would appear as a very thin transparency, since the initial overexposure has affected the major portion of the silver halides. A considerably smaller amount of halides remains to be affected by reexposure in the reversal bath and color development. The highlights appear washed out, as little dye is produced. Underexposure, as shown in C, affects less than one-half of the silver halides in the color emulsion. Therefore, when the reversal process forms the positive image, the greater part of the silver halides is affected by reexposure and color development. This results in a much denser positive image which is more satisfactory than an overexposed image.

NOTE: Your understanding of this will increase when we cover processing of reversal film. For now just try to get the idea that as you increase exposure over normal the final transparency will be lacking in color. Conversely, as you decrease exposure, the transparency will become darker and darker.

Exercises (668):

1. What is the exposure latitude of reversal color film?

2. A scene's contrast should not exceed what ratio when using reversal film?

3. What is one way you can reduce a scene's contrast?

4. Heavy dye densities result from what type of reversal exposures?

5-4. Filters for Color Photography

Color film, unlike the eye, is designed to record light of a specific Kelvin temperature: 5400 K for daylight films and 3200 K for tungsten films. Filters are therefore necessary to filter the available light to match the film. There are four categories of filters that perform

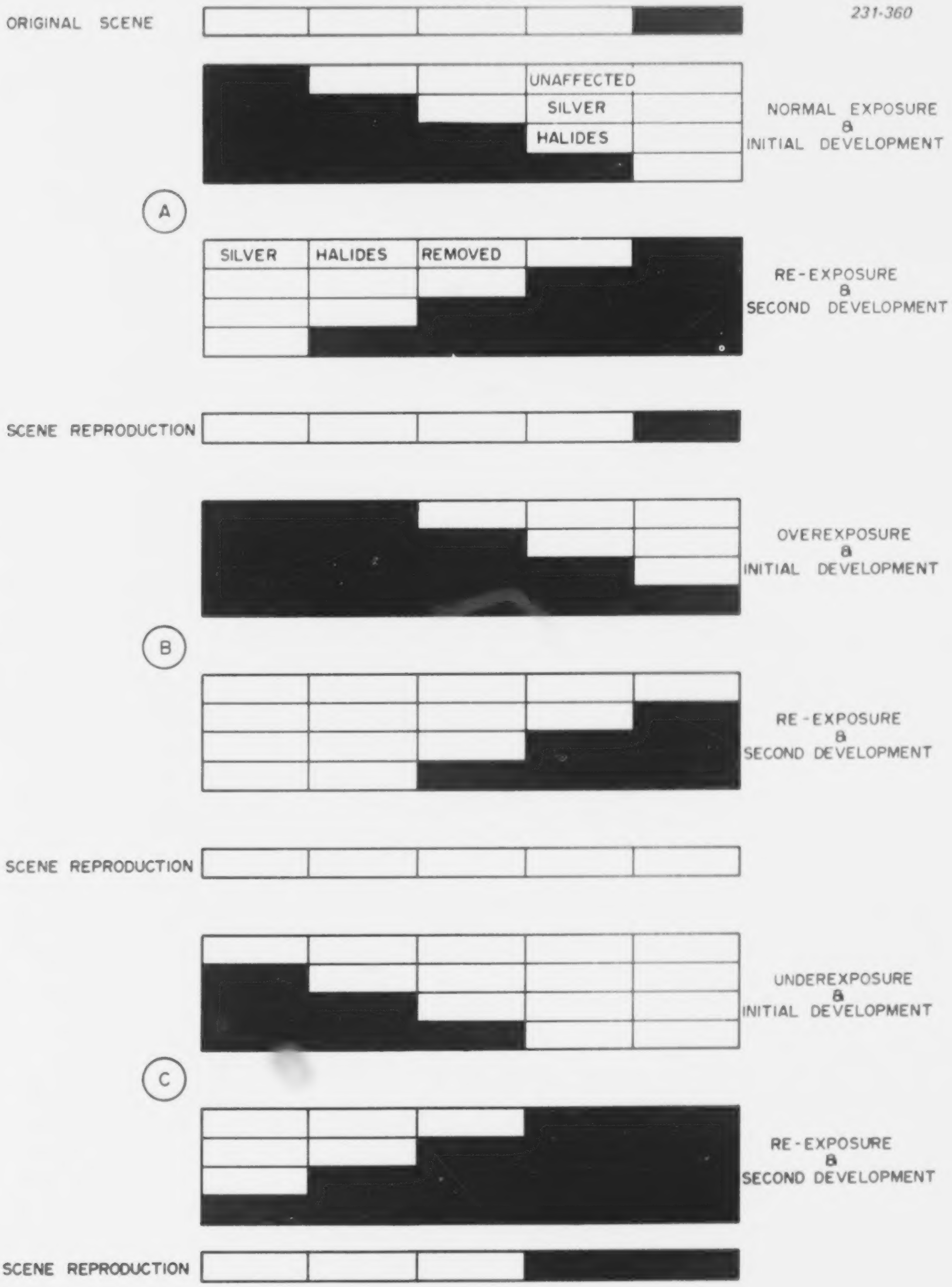
231-360
ORIGINAL SCENE
UNAFFECTED
SILVER
HALIDES
NORMAL EXPOSURE & INITIAL DEVELOPMENT
A
SILVER HALIDES REMOVED
RE-EXPOSURE & SECOND DEVELOPMENT
SCENE REPRODUCTION
OVEREXPOSURE & INITIAL DEVELOPMENT
B
RE-EXPOSURE & SECOND DEVELOPMENT
SCENE REPRODUCTION
UNDEREXPOSURE & INITIAL DEVELOPMENT
C
RE-EXPOSURE & SECOND DEVELOPMENT
SCENE REPRODUCTION

Figure 5-8. Exposure latitude of reversal film.

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this task: (1) conversion filters, (2) light-balancing (correction) filters, (3) color compensating filters, and (4) special purpose filters. Filters for color photography are less dense than those used for black-and-white photography, but their principles of application are the same.

669. Choose the correct filter to be used under different photographic situations involving color film.

Conversion Filters. Conversion filters are very strong filters and are used for exposing tungsten-type color films under daylight conditions and daylight film under tungsten illumination. The following list indicates the filter to use:

Film Type	Lighting	Filter	F Stop Increase
Daylight	3200 K Lamps	80A	2
Daylight	3400 K Lamps (Photofloods)	80B	2 2/3
Daylight	Clear Flash (3800 K)	80C	1
Type B (Balanced for 3200 K)	Daylight	85B	2/3

NOTE: Type 80 filters are blue in color, whereas 85's are yellowish. This and other lists in this section are just guides. You must follow the recommendations of the film's manufacturer.

Light Balancing Filters. Light balancing filters are paler than conversion filters. They are used for slight adjustments within the general light balance of the film (i.e., matching type B film to different types of tungsten lighting, etc.). The following is a list of commonly used light balancing filters:

Film Type	Filter	Purpose	F Stop Increase
Daylight	81A	Absorbs excess blue in cloudy weather, shade or when using electronic flash indoors.	1/3
Type B	81A	When using type B film with photofloods.	1/3
Daylight	81B	Same application as an 81A but with stronger results.	1/3
Daylight	82A	Reduces the excessive warmth found in early morning and late afternoon light.	1/3

NOTE: 81 filters are yellowish, whereas an 82 is a bluish filter.

Color-Compensating Filters. Color-compensating filters come in pale tints of red, green, blue, magenta, yellow, and cyan. They are used to make very subtle color changes. A very large selection of densities are available, as shown in table 5-2. For this reason color-compensating filters are available in gelatin sheets.

Special Filters. Special filters have been designed for specific light-balancing problems. The following list shows a few filters that are available.

FILM TYPE	FILTER	PURPOSE	F STOP INCREASE
Daylight	FLD	Eliminates the blue-green cast which results when shooting daylight film under fluorescent lighting.	1
Type B	FLB	Used when shooting type B film under fluorescent lighting.	1
Daylight	CC30R	When using daylight film underwater.	2

Exercise (669):

1. Which filter would you choose for each of the following situations?
   a. Shooting daylight film with tungsten lighting.
   b. Using type B film with photofloods.
   c. Shooting type B film under fluorescent lights.
   d. Using daylight film underwater.
   e. When shooting daylight film indoors with electronic flash.
   f. Shooting daylight film with clear flash.
   g. Shooting daylight film in the early morning.

5-5. Duplicating Transparencies

In the Air Force there is an ever-increasing need for color slides for audiovisual presentations. Slides are used in presentations for briefings, newcomer's orientations, and especially in training programs. Any subject that can be photographed or copied can be made into a color slide. Duplicating color slides is

TABLE 5-2
TYPICAL COLOR-COMPENSSATING (CC) FILTERS

Filter Nomenclature	*Color*	** Color Density*	*Exposure Increase in Stops*
CC 025 R	Red	0.025	—
CC 05 R		0.05	1/3
CC 10 R		0.10	1/3
CC 20 R		0.20	1/3
CC 021 G	Green	0.25	—
CC 05 G		0.05	1/3
CC 10 G		0.10	1/3
CC 20 G		0.20	2/3
CC 025 B	Blue	0.025	—
CC 05 B		0.05	1/3
CC 10 B		0.10	1/3
CC 20 B		0.20	2/3
CC 025 Y	Yellow	0.025	—
CC 05 Y		0.05	—
CC 10 Y		0.10	1/3
CC 20 Y		0.20	1/3
CC 025 C	Cyan	0.025	—
CC 05 C		0.05	1/3
CC 10 C		0.10	1/3
CC 20 C		0.20	1/3
CC 025 M	Magenta	0.025	—
CC 05 M		0.05	1/3
CC 10 M		0.10	1/3
CC 20 M		0.20	1/3

Note: * All the above filters are also available in additional densities of .30, .40, and 50. If filters are used in combination, exposure increase should be obtained by trial and error.

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the main duplication task of many photo labs. There are many different types of slide duplication cameras used throughout the Air Force and they range from simple to very complex. A common one that is widely used is the Repronar Model 805 slide duplicating camera.

670. Using figures 5-9 and 5-10, identify the basic features of the Repronar 805 slide duplicating camera.

Equipment Requirements. Regardless of the equipment that you use to duplicate transparencies, it must meet some basic requirements. You need a 35mm single-lens, reflex camera capable of 1:1 reproduction. The light source for making the exposure must be behind the slide, and a piece of diffusion glass must be used between the slide and the light source to diffuse and even out the light. The commercial duplicating equipment available for slide duplicating have refinements of and additions to these basic requirements.

Repronar 805. The Repronar 805 (figs. 5-9 and 5-10) is a special-purpose copy apparatus specifically designed for duplicating transparencies. It is a fully self contained unit complete with the camera, copy stage, and viewing and exposing light sources. It is capable of making same size, enlargements, and reductions of transparency images.

The camera is a 35mm single-lens reflex equipped with a long, flexible bellows and an f/4 flat field, copy lens. The camera is situated on vertical rails above the copy stage. This configuration is very similar to a projection printer and permits magnification, reduction, and critical focusing of the transparency image. The camera is capable of 4X magnification and 50 percent reduction. The reduction can be used to reduce 2¼ X 2¼ (6X6cm) slides to 35mm size.

An exposure compensation calculator indicates the change in exposure required when making magnifications. It is set by dialing in the film value number of the film that you are using. This film value number is not the same as the film ASA rating. It is a number assigned to the film by the manufacturer of the Repronar. You can find the film value number for different films in the instruction manual for the Repronar.

The exposing light source is electronic flash and is situated below the copy stage. It has a high/low power switch for controlling exposure. There is also a filter drawer directly beneath the copy stage. Different filters can be inserted to alter color balance or create special effects.

1· MAGNIFIER–Enlarges a portion of the image for sharpest focusing. Swings out of the way for normal viewing.

2. VIEWER–Provides an accurate, full-sized image on hooded ground glass for composing and focusing.

3. CRANK FOR REWIND–Crank unfolds for ease of rewinding film into cassette.

4. CAMERA CASE LATCH–Secures the removable camera back.

5. CAMERA CARRIAGE LOCKING LEVER–Locks the camera carriage in final position after final focusing. Provides one-hand operating ease.

6. CAMERA TRAVEL KNOB–Moves the camera on a helical gear and rack mechanism for easy focusing.

7. LENS CARRIAGE TRAVEL KNOB–Large, easy to grasp knob provides quick and positive positioning of lens carriage.

8. WORK TABLE (EASEL)–Provides level work area of steel for smooth positioning. Easy to keep clean.

9. BASE–Cast metal housing for electronic flash light source. Design and finish both pleasing and functional.

10. THREADED HOLES–Drilled and tapped for 8/32 slide holder thumb screws.

11. NAMEPLATE AND CONTROL PANEL–Gives unit identification and directions for proper switch positioning.

12. READY LIGHT–Glows when the FLASH-VIEW switch is in the flash position, indicating that the Repronar is ready for coping–the view light is off, and the electronic flash is ready to be fired.

13. FLASH-VIEW SWITCH–In flash position, the switch completes the circuit for firing the electronic flash with the camera shutter release: in view position, the switch turns on the view light for illuminating the transparency.

14. HIGH-LOW SWITCH–Controls power output of electronic flash. When in the HIGH position the unit deliver four times (two f/stops) the amount of light as when in the LOW position. The power output in the LOW position is the same as the previous models of the Repronar.

15. ON-OFF SWITCH–Functions as the master switch for the Repronar. The view light and electronic flash operate only when this switch is in the ON position.

16. FILTER COMPARTMENT AND HOLDER–Filter holder slides in and out of the filter compartment easily, allowing insertion of filter without disturbing copy or opal view glass.

17. LENS CAP–Protects lens when not in use.

18. APERTURE SELECTOR–Controls the action of the lens diaphragm. Pointer indicates working aperture which is printed on the Aperture Index Scale.

19. f/STOP MARK–Indicates proper positioning of the diaphragm ring.

20. DIAPHRAGM RING–Rotates (click stops) to pre-select the proper f/stop. The Aperture Selector will stop when being moved from right to left, at the position indicated by the Diaphragm Ring.

21. APERTURE INDEX SCALE–Serves as an f/stop indicating scale for the Aperture Selector. Numbers on the scale represent full f/stops with half-stops indicated.

22. BELLOWS–Allows freedom of movement between camera body and lens.

23. CABLE RELEASE–Operates the shutter and fires electronic flash in synchronization.

24. FILM ADVANCE LEVER–Advances film and cocks the shutter in readiness for the next exposure.

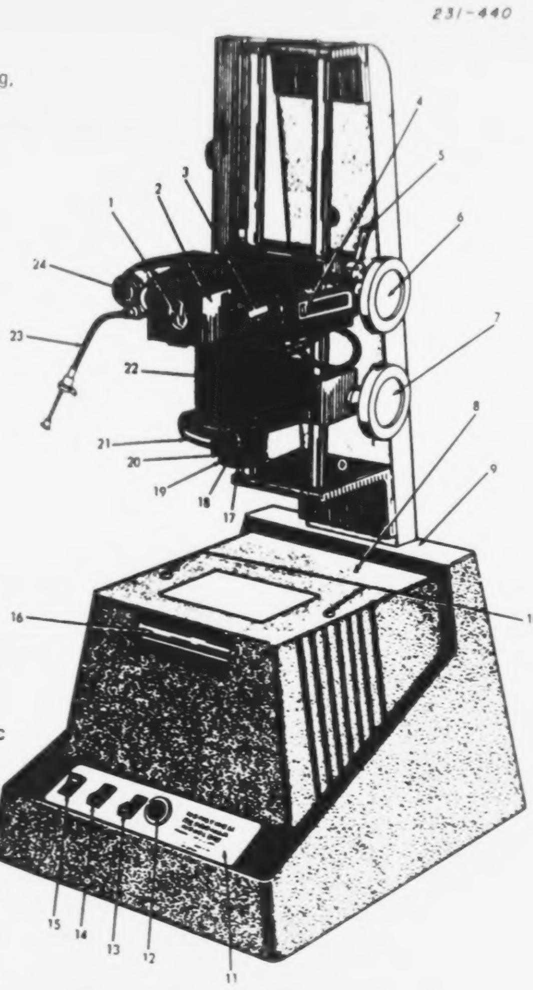
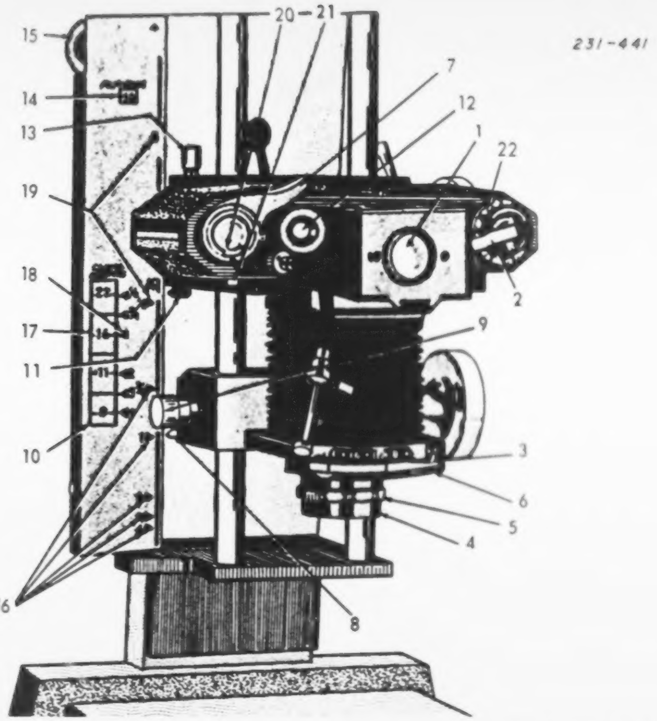


Figure 5-9. Repronar 805 slide duplicating camera.



1. MAGNIFIER—Enlarges a position of the image for sharpest focusing. Swings out of the way for normal viewing.
2. CRANK FOR REWIND—Crank unfolds for ease of rewinding film into cassette.
3. APERTURE SELECTOR—Controls the action of the lens diaphragm. Pointer indicates working aperture which is printed on the Aperture Index Scale.
4. f/STOP MARK—Indicates proper positioning of the diaphragm ring.
5. DIAPHRAGM RING—Rotates (click stops) to pre-select the proper f/stop. The Aperture Selector will stop when being moved from right to left. at the position indicated by the Diaphragm Ring.
6. APERTURE INDEX SCALE—Serves as an f/stop indicating scale for the Aperture Selector. Numbers on the scale represent full f/stops with half-stops indicated.
7. FILM ADVANCE LEVER—Advances the film and cocks the shutter in readiness for the next exposure.
8. LENS CARRIAGE POINTER—Indicates on the Exposure Calculator the magnification of the copy and the lens aperture for a normal exposure.
9. LENS CARRIAGE LOCKING SCREW—Locks lens carriage at selected position.
10. APERTURE WINDOW—Shows correct aperture settings for different amounts of magnification.
11. CAMERA CARRIAGE POINTER—Indicates settings to correspond with the lens carriage pointer, providing quick positioning of the camera for approximate focus. From this position, focusing is easily completed while the sharpness of the image is observed on the ground glass.
12. SHUTTER KNOB—Rotates as shutter is cocked (clockwise) and released (counterclockwise) Acts as selector for"I" and "B" settings.
13. MOTOR DRIVE LOCKING SCREW—Locks motor drive in proper position.
14. FILM INDEX WINDOW—Shows choice of film index.
15. SELECTOR WHEEL—For selecting proper film index.
16. MAGNIFICATION SCALE-LOWER—Used as reference points for the lens carriage pointer.
17. CAMERA APERTURE BAR—Gives correct aperture for various amounts of magnification.
18. MAGNIFICATION INDEX FOR APERTURE WINDOW—Used as reference points for exposure selection.
19. MAGNIFICATION SCALE-UPPER—Used as reference points for the upper pointer attached to the camera carriage.
20. EXPOSURE COUNTER—Shows how many frames have been exposed. Indicates numbers from——2 to 37. Automatically resets to —2 when camera back is released.
21. DOUBLE EXPOSURE BUTTON—Allows the shutter to be cocked for multiple exposures without moving the film.
22. FILM REMINDER DIAL—May be used as a reminder as to what kind of film is in the camera body.

Figure 5-10. Repronar 805 camera and exposure calculator.

Basic Operation. The Repronar camera is loaded (and unloaded) like other 35mm reflex cameras. Once the camera is loaded, the following steps are taken to duplicate a slide:

(1) Set the on-off switch to the ON position.

(2) Push the flash-view switch to the VIEW position.

(3) Be sure the film has been advanced and the shutter cocked before focusing and composing.

(4) Open the aperture selector to f/4 to give maximum illumination for viewing.

(5) Place the transparency to be copied emulsion down in the slide holder.

(6) Establish the correct magnification by adjusting the lens and camera carriages. Composition may be established through a combination of magnification and moving the slide holder on the copy stage.

(7) Set the correct aperture as indicated by the aperture bar.

(8) Push the flash-view switch to flash.

(9) Depress the shutter release making the exposure.

(10) Turn the film advance lever a full stroke to advance the film and cock the shutter for the next exposure.

Exercises (670):

1. With the aid of figures 5-9 and 5-10, select the basic features of the Repronar 805 from the following list:
   a. Rangefinder focusing.
   b. Bellows system.
   c. Double exposure capability.
   d. 4 x 5 film capacity.
   e. Quartz exposure lights.
   f. Permits a 400 percent enlargement.
   g. 35mm film capability.
   h. Ground-glass focusing.
   i. Copies 2¼ square transparencies.
   j. Electronic flash exposure system.
   k. Built-in exposure meter.
   l. Copies black-and-white negatives.

671. Specify principles and techniques of slide duplication.

Although the Repronar 805 is very common in the Air Force, some labs may have different equipment for duplicating slides. There are basic concepts and techniques of duplicating slides no matter what type of duplication setup you are using.

Films for Slide Duplication. Slide duplication film is different from the film that you would use to take an original exposure. It has lower inherent contrast and wider exposure latitude than normal reversal color film. If normal reversal color film is used to copy a slide, the duplicated slide will pick up objectionable contrast. Washed out highlights and blocked up shadows are typical of slides duplicated with normal color reversal film. Refer to Air Force or commercial stock listings for the types of slide duplicating films that are available. You can also duplicate black-and-white slides with this film or any color reversal film for that matter. This is advantageous if your lab does not have a black-and-white reversal film processing capability.

Corrections During Duplication. One of the advantages of duplicating a slide is that you can make corrections for imperfections in the original slide. Slides that have been under or overexposed or have improper color balance can be corrected during duplication. The image can be magnified and distracting elements cropped out to improve composition.

Proper filtration is very important in slide duplication. Filters are normally used even when the slide appears to have correct color balance. Basic starting filtration is given in the film data sheet for the film that you are using. This is only starting filtration because actual filtration may be different depending upon the lighting and film that you are using and variations in processing. The only way that correct filtration can be determined is through the use of trial filtration and subsequent processing. The test slides are then viewed for exposure and color balance.

When copying an underexposed slide, increase exposure the equivalent of two f/stops for each f/stop of apparent underexposure in the original slide. This same general rule applies to overexposed slides only the situation is reversed. Stop down two f/stops for each f/stop of apparent overexposure in the original slide. Overexposed original slides are harder to correct than underexposed slides. This is because an overexposed slide has very little color saturation and you cannot put into a copy slide what is not already there in the original. In underexposed slides, the colors are oversaturated and making a correction is easier.

Many creative techniques can be used when duplicating slides. In fact, many times, slides are duplicated for this express purpose. Multiple images, overprinting of titles, etc., can be done during duplication.

Slides are used extensively as the visual element for briefings, training, as the like. Their applications within the Air Force are unlimited. You should practice shooting and duplicating slides to improve your techniques.

Exercises (671):

1. How much exposure compensation is required to correct a slide that was originally one f/stop underexposed?

2. When duplicating a color slide, where is the exposing light source positioned in relation to the slide?

3. Of what degree of magnification is the Repronar 805 capable?

4. How is filtration determined when duplicating color slides?

5-6. Processing Color Reversal Film

Color film processing is a little more difficult than black-and-white processing, because you must follow all directions and procedures exactly. Any change from given standards will affect the quality of your finished slides. In this section we discuss the purpose of the chemical steps, mixing procedures, and processing requirements for color reversal film using the E–6 process.

672. State the purpose of each chemical step used in the E-6 process.

There are seven chemical steps involved in the processing of color reversal films using process E–6. The names of these steps and the order in which they are prepared and used is: first developer, reversal bath, color developer, conditioner, bleach, fixer, and stabilizer. The purpose of each step is as follows.

First Developer. The first developer is essentially a black-and-white negative developer. It produces a black metallic silver image on color reversal film. This is the most critical step of the process.

Reversal Bath. The reversal bath contains a chemical that affects silver halides the same way that light does. Its purpose is to chemically expose all the remaining silver halides that were not exposed in the camera.

Color Developer. The color developer performs two functions. The first function is to develop the silver halides that were "exposed" in the reversal bath. The second function is to create the dye image. Here, developer that has oxidized from developing the silver halides reacts with color couplers built into the film and forms cyan, yellow, and magenta dyes in their respective film layers. The amount of dye formed is in direct proportion to the amount of silver formed in the color developer.

Conditioner. The conditioner is a necessary preliminary step before the bleach step. It conditions the metallic silver that was formed by the first and color developers so that it can be converted back into silver halides by the bleach.

Bleach. The bleach converts the metallic silver images back into silver halides so that they can be removed from the film by the fixer.

"**Fixer. The function of the fixer is to break down the silver halides to soluble complexes of silver. Once the silver halides are converted to silver complexes, they remain in the fixer solution. The fixer used in the E-66 process is therefore rich in silver after use and this silver should be recovered.**"

Stabilizer. The stabilizer improves the stability of the dyes to make them permanent. It also contains a film wetting agent to promote even drying.

Exercises (672):

1. What is the function of the first developer in the E–6 process?

2. What step must be accomplished before color reversal film is bleached and why?

3. Which chemical step forms color dyes?

4. State the two purposes of the stabilizer step.

5. What is the purpose of the reversal bath?

6. What does the fixer do to the film?

673. Specify the procedures for preparing E-6 color reversal film processing chemistry.

The trend in photographic chemicals in recent years is towards convenience. In past years chemicals were mixed from bulk using a formula. The prepackaged chemistry became available, which eliminated the need for using a formula but most of the chemistry was of the dry chemical type. Now, many manufacturers have gone another step for the sake of convenience for those who use their products. The latest type of chemistry available is the concentrated liquid type. Chemistry for process E–6 is provided by the manufacturer in easy to use liquid concentrate form. All that you have to do is mix the concentrate with a specified amount of water.

Even though the chemistry is relatively easy to prepare, there are precautions and procedures that you must follow to prevent contamination and insure your safety.

Before you start mixing your chemistry, determine the volume of chemicals that you will need. All the chemicals for the E–6 process are available in 1/2 or 1 gallon, (1.89 or 3.79L) size kits. Mix the size that your equipment dictates. If you process film in small batches using roll film reels and tanks, then the 1.89

liter size should be prepared. Use a mixing vessel to prepare the 1.89 liter and transfer your mixed chemicals into 1.89 liter stoppered bottles. Some labs use a sink line of 3½ gallon (13.25L) deep tanks. For this situation you will need three 3.79 liter kits and one 1.89 liter kit. For a 13.25 liter setup you can mix your chemicals in the same tanks that you use for processing.

It is very important during mixing that you avoid the possibility of contamination. First of all, all chemcals cannot be mixed using the same mixing vessel. You will need three mixing vessels to prepare chemicals for storage in bottles. The following chemicals can be mixed using the same mixing vessel.

- First and color developer.
- Reversal bath, conditioner, and bleach.
- Fixer only.

The purpose of using three mixing vessels is to avoid reverse contamination. Use some way to identify each vessel: A, B, C, etc., so that you can avoid contamination when mixing E-6 chemistry at a later date. Start with clean mixing equipment, rinsing mixing vessels with warm water before using them. Mixing the exact volume required is essential because one that is over-diluted or too concentrated will adversely affect your film. Mark each mixing vessel at the exact level for the amount of chemicals that you are preparing. Start by filling the mixing vessel with water at the specified temperature and leaving enough room in the vessel so that when the liquid concentrate is added, the volume is still short of the mark. Slowly pour the liquid concentrate into the water while at the same time stirring the solution with a stirring rod. Mix in the proper order as shown previously. If the chemical step that you are preparing contains two parts, be sure that you mix them in their proper order also. After you have poured in all of the concentrate, top up the solution to the proper level and continue to stir the solution until it is completely mixed. This won't take long. After each chemical is mixed, pour it into its storage bottle making sure that you have already rinsed out the bottle of any residue from previous storings.

Mixing the chemicals in their processing tanks is a little easier because you don't have to worry about mixing vessels but you should have each tank marked with the appropriate solution and not interchange them when remixing. Each tank should be thoroughly cleaned before mixing begins. The same precautions to prevent contamination apply when mixing in the processing tanks. Also make sure that you have your tanks marked at the proper volume.

Storage. Before they are mixed, E-6 chemicals have a shelf life of one year or longer under proper storage conditions. However, once they are prepared, their life is shortened considerably whether they are used or not. You can get maximum life from your chemistry if you store it properly. The tanks used in a processing line should have floating tank lids, and the bottles used to store chemicals should be of the dark amber type and tightly stoppered. Also use the proper volume bottles. If you use a large bottle and only fill it halfway full, the air trapped in the bottle above the liquid will oxidize the chemistry. So, only full, tightly stoppered, dark amber bottles should be used when storing your chemicals in bottles. The following table lists the approximate storage time for both used and partially used solutions under different storage conditions.

Solution	Tanks & Floating Lids or full, stoppered bottles		Partially filled, stoppered bottles, Used Unused
	Used	*Unused*	
1st Dev	8 wk	4 wk	1 wk
Rev Bath	8 wk	4 wk	
Conditioner	8 wk	4 wk	
Color Dev	12 wk	8 wk	6 wk
Bleach	24 wk	24 wk	24 wk
Fixer	24 wk	24 wk	24 wk
Stabilizer	24 wk	24 wk	24 wk

Exercises (673):

1. Chemisty for process E-6 is provided in the ______ __________ form.

2. E-6 processing kits are available in 1 2 and ______ sizes.

3. The purpose of using three mixing vessels to prepare E-6 chemistry is to avoid ______________ .

4. The storage life of first developer in partially filled, stoppered bottles is __________ __________ .

5. Floating tank lids should be used to prevent ____ .

674. Given a series of statements about color reversal film processing indicate the proper procedure or requirement for each situation.

The most common size of color reversal film that you will have to process will be 35mm size. 35mm film is processed on individual reels and can be processed in small tanks or in large tanks through the use of a special processing rack. Besides the chemical steps already mentioned, there are two integral washes that must be done. The first wash is immediately after the developer and it acts as a stop bath and prevents carryover of developer into the reversal bath. The second wash is the final wash before the film is stabilized. It removes the fixer from the film and must be thorough so that the finished slides does not change color or fade with age. The following is a tabulation of processing times and temperatures for each processing step.

SOLUTION	TIME (Min)	TEMPERATURE	
		F.	C
First Developer	6:15	100.4 ± 0.5	38.0 ± 0.3
First Wash	2	92 - 102	33 - 39
Reversal Bath	2	92 - 102	33 - 39
Use normal room lighting after one minute in the reversal bath			
Color Developer	6	100.4 ± 1.1	38.0 ± 0.6
Conditioner	2	92 - 102	33 - 39
Bleach	6	92 - 102	33 - 39
Bleach	6	92 - 102	33 - 39
Fixer	4	92 - 102	33 - 39
Final Wash	4	92 - 102	33 - 39
Stabilizer	:30	Room temperature	
Dry		68 - 140	20 - 60

Processing times are very critical for each step, just as are the temperature tolerances for the first and color developers. All of the times given include a ten second drain time at the end of each step.

Step-by-Step Procedures. Let's go through the step-by-step procedures that you should use to process your film.

Preparation. Preparation involves getting your processing chemicals up to working temperature, loading processing reels, and other minor tasks. To get your chemicals up to working temperature you will have to have some sort of water jacket to surround the chemicals. When processing with small tanks your storage bottles can be placed in a water jacket or stoppered sink so that they are partially submerged. A temperature-controlled supply of water flowing into the sink or water jacket and a water outlet provide the requirement for a flow of temperature controlled water, which will quickly bring your chemicals up to their proper processing temperatures. Make sure that your first developer temperature is exactly right before you begin to process. While you are waiting for your developer to come up to temperature, you can load your film onto reels and secure them in a light-tight container. The first two steps and part of the third step must be done in total darkness. Of course, if you are processing in a daylight tank, room lights can be used for the entire process and the tank cover can be removed after one minute in the reversal bath. When processing in a sink line, be sure that you remove the floating lids and fill your wash tank before you turn out the lights. Insure adequate ventilation. (Some labs have power ventilators.) This is important in an enclosed environment such as a photographic darkroom.

Agitation. Proper agitation of your film during development is very important; because if you don't do it right, you will get poor results. The type of agitation you should use depends upon the film format that you are processing, the amount of film that you have to process, and the types of processing equipment that are available for you to use.

To process only a few rolls of film, it is more efficient to use a daylight tank and reels. Larger batches of roll or sheet film are normally processed in a sink line arrangement.

The two basic types of agitation that you can use to process your film are manual and gaseous-burst agitation. Manual agitation involves the movement of the film in the solution whereas in gaseous-burst agitation, the solution is agitated while the film remains stationary. Manual agitation can be used for both small tank and sink-line processing. Gaseous-burst agitation is limited to sink-line operations only and can be used only for sheet films. Roll film on reels cannot be agitated by gaseous burst because processing streaks will occur.

Probably, most of the film processing that you will do will be roll film processing in small or large batches. Let's talk about manual agitation of roll films in both small, day-light tanks and in sink lines.

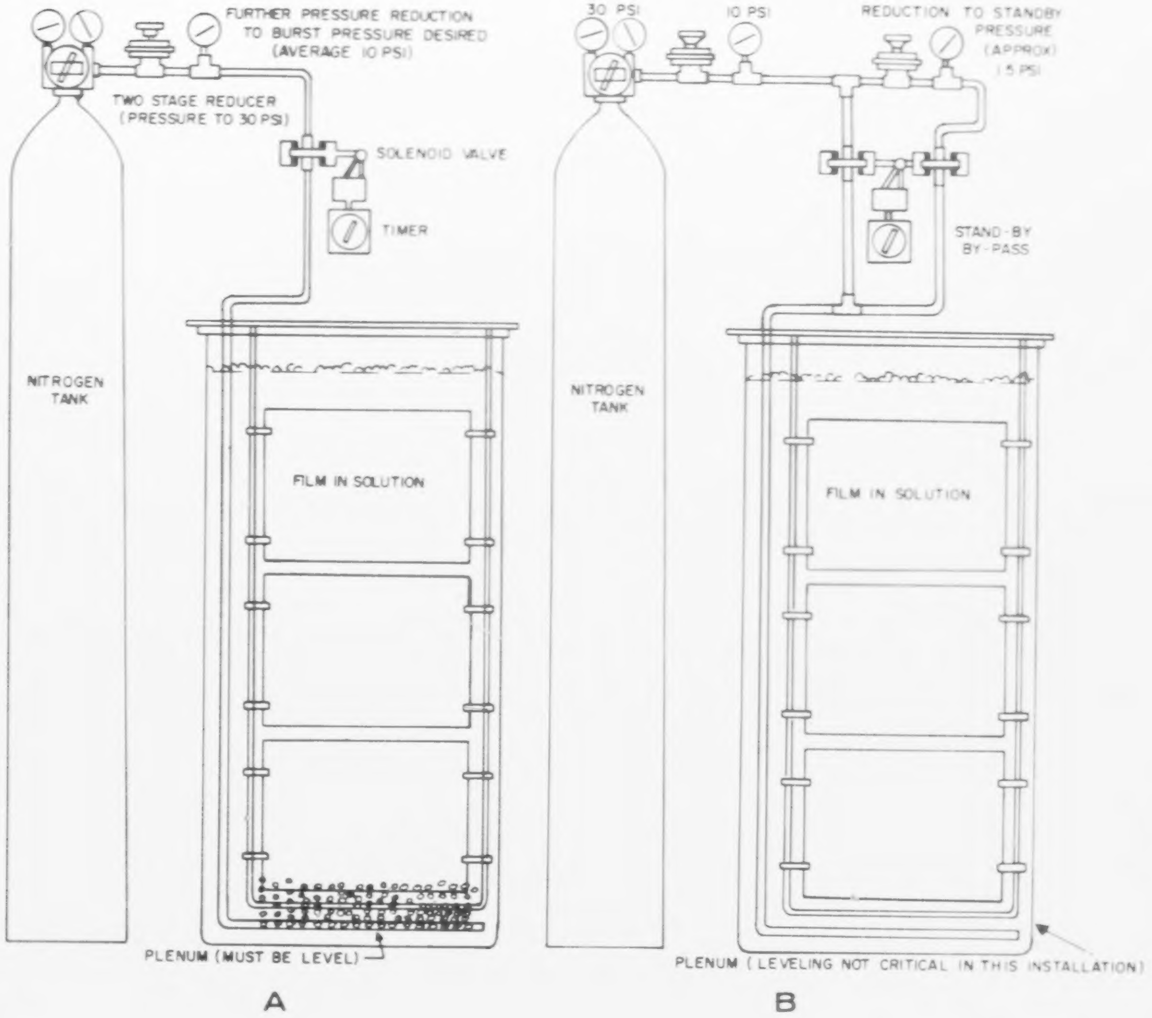
Small daylight tank agitation. There are two ways to begin processing. Either pour your first developer through the light-trapped holed in the top of the daylight tank cover or fill the tank with developer and leave the cover off until you have immersed the film into the developer. The method of immersing the film into the developer is preferred because it promotes more even development. Regardless of the method that you use to start your process, begin the agitation sequence by tapping the bottom of the tank against your work surface or sink bottom to dislodge any air bubbles that could be present in the solution. Now begin agitation by holding the tank securely in one hand and inverting it and returning it to the upright position a number of times, (approximately 8 times) until 15 seconds has elapsed on your timer. After this initial agitation, wait 30 seconds and repeat the agitation cycle of five seconds every thirty seconds for the duration of the processing time. Use this agitation procedure for the first developer, color developer, bleach, and fixer steps. The reversal bath, conditioner, and stabilizer do not require any agitation except to tap the tank to dislodge air bubbles at the beginning of the step. For the wash steps, remove the daylight tank cover and let a stream of running water enter the tank. For agitation, dump the tank at intervals throughout the wash. Also, remember that the first wash is done in darkness.

Sink line manual agitation. You can manually agitate sheet and roll films when processing in a sink line ($3\frac{1}{2}$ gallon tanks). Here's the procedure. For all solutions; tap the processing rack, film hangers, or reels (whatever you are using) against the bottom or a side of the tank to dislodge air bubbles. For the reversal bath, conditioner, and stabilizer, dislodging the air bubbles is the only agitation that should be done. For all other solutions including the washes, use the following agitation procedure. Lift the film most of the way out of the solution and reimmerse it for an initial agitation cycle of 15 seconds. In 15 seconds you should be able to get in about eight lift, tilt, reimmerse cycles. This would be about average, but don't try to do it too quickly because you may cause splashing.

After initial agitation, subsequent, intermittent agitation is on a 5-seconds each 30 seconds cycle of lifting, tilting, and reimmersing to agitate the film during the remainder of the processing time.

Gaseous-burst agitation. Sheet films may be agitated manually or with a combination of manual and gaseous-burst agitation. When using the gaseous-burst, the initial agitation must be manual and subsequent agitation is by gaseous burst.

Gaseous-burst systems cause turbulence (agitation) of a solution by forcing gas through it. Gas is released at the bottom of the tank causing bubbles to rise through the solution and dissipate when they reach the solution surface. A gaseous-burst agitation system is illustrated in figure 5-11. It requires a number of items such as bottles of compressed nitrogen and compressed air, pressure regulators, a timer to control the interval and duration of each burst of gas, a plenum, distribution lines to carry the gas to each tank, and finally a gas distributor in each tank where the agitation system is used. A series of small holes in the gas distributor vents the gas into the solution.


FURTHER PRESSURE REDUCTION TO BURST PRESSURE DESIRED (AVERAGE 10 PSI)
TWO STAGE REDUCER (PRESSURE TO 30 PSI)
SOLENOID VALVE
TIMER
NITROGEN TANK
FILM IN SOLUTION
PLENUM (MUST BE LEVEL)
A
30 PSI
10 PSI
REDUCTION TO STANDBY PRESSURE (APPROX) 1.5 PSI
STAND-BY BY-PASS
NITROGEN TANK
FILM IN SOLUTION
PLENUM (LEVELING NOT CRITICAL IN THIS INSTALLATION)
B

A Single solenoid burst system

B Standby pressure system

Figure 5-11. Gaseous-burst agitation system.

Nitrogen gas must be used for the developers. This is because it is inert and will not oxidize the developing solution. Air is used in the bleach and fixer. The bleach requires aeration in order for it to work properly, so air-burst agitation aerates the bleach and agitates the film at the same time. The agitation cycle for gaseous-burst agitation is a 2-second burst every 10 seconds.

The reversal bath, conditioner, washes and stabilizer, are not agitated by gaseous burst and manual agitation procedures apply to them. Gasous-burst systems have some advantages over manual agitation alone. The agitation, being automatic and controlled, may be more uniform than manual agitation. Also there is less chance of contamination from sloshing chemistry into the other tanks which can happen during manual agitation. The cost of setting up and maintaining a gaseous-burst agitation is obviously more expensive and is usually not justified unless your lab does a high volume of color reversal sheet film processing.

Exercises (674):

1. In which step of color reversal film processing is the solution temperature the most critical?

2. At what point in color reversal film processing may normal room lighting be used without affecting the film?

3. What method of film processing should be used when only a few rolls of film are to be processed?

4. What method of agitation can be used when processing roll film on reels?

5. What method of agitation will cause processing streaks on roll film that is processed on reels?

6. How are air bubbles dislodged from the film in processing?

7. Which solution in the color reversal film process must be aerated to work properly?

8. What method(s) of agitation is used to process color reversal sheet film?

5-7. Slide Finishing

Making color slides is a critical procedure. There is a direct cause-and-effect relationship between each step in the process. An error in any step will affect the outcome of the finished slide. Therefore, you can't make allowances for any errors from the time of the exposure until the slide is placed in the mount.

It would be a terrible shame for the slide to be perfect and then have someone ruin it during the mounting step. This next section deals with the proper methods of slide finishing.

675. State the techniques used to dry color reversal film.

You already know quite a lot about film drying from previous discussions in black-and-white film finishing. The drying of color reversal film is not much different than for black-and-white. The important thing to remember is that you must do everything properly.

The stabilizer is the last wet step before you dry your film. Unlike black-and-white film you do not have to use a separate wetting agent bath because the wetting agent is included in the stabilizer.

You can dry your film naturally or use a film dryer. Avoid excessive heat when drying your film because it can cause your film to curl. The film manufacturer recommends a temperature range of 68° to 140° F (20° to 60° C) for film drying but it would be safer not to exceed 125° F (52° C).

Hang your film up to dry in the conventional manner attaching a stainless steel film clip to the bottom of each roll. You can squeegee your film with a soft sponge soaked in stabilizer and then rung out. Squeegee the film on both sides making only one pass with the sponge per side.

Be sure that you wash your film processing reels in hot water to remove any chemicals before letting them dry.

When your film has dried completely, inspect it for dirt or scum. If you find any, the film will have to be rewashed and restabilized. Scum on your film can usually be traced to the stabilizer so remix the stabilizer while you are rewashing your film. In labs that do a lot of color reversal film processing it is good practice to change the stabilizer once weekly.

Exercises (675):

1. What is the drying temperature range for color reversal film?

2. How should color reversal film be squeegeed?

3. What happens when excessive heat is used to dry your film?

676. List the advantages and disadvantages of various methods of mounting slides.

There are many methods of mounting slides, each with certain advantages and disadvantages. Slides may, for example, be mounted in cardboard, glass, plastic, and combinations of these materials. We will go over the basic types and the use of a slide mounter.

Tape and Glass. Some of the first film clips to be mounted as slides were mounted between two pieces of glass taped on the edges to hold the sandwich together. This is the most time consuming and costly way to mount slides; however, so durable is this method that it is still practiced today, especially in larger lantern slides. When properly assembled, this type of slide will survive an amazing amount of abuse short of glass breakage. Recently, waterproof tapes have been developed which makes it possible to remove almost any type of surface contaminants this slide may encounter.

Metal With Glass. This type of mounting provides a high degree of protection and is generally less time consuming to assemble than tape and glass. Some mountings of this type are thicker than standard slide trays and may tend to jam or stick in automatic slide changers. Manufacturers of automatic changers have realized this fact and several have redesigned their equipment to accommodate this popular method of slide preparation.

Plastic With Glass. This is the most popular glass mounted slide. It has the best features of the metal and glass type but costs less and is thinner. Some have less impact resistance than metal slides; and as is the case with all glass mounted slides, the tendency to form Newton Rings is present.

Newton Rings. These are optical interference patterns that result when humidity causes a very slight irregular separation between two or more optically flat plane parallel surfaces. The pattern appears as a variable area of color similar to that seen on an oil slick or in a soap bubble. To eliminate this troublesome occurrence, the optical flats must be separated. This can be accomplished at great time loss by scrubbing the glass surface with scouring powder or at less time loss by dusting the film or glass with offset powder. When employing the offset powder technique, it is important to use a non-toxic, non-abrasive, inert powder, and a light touch. Stop Offset Spray Powder Grade No. 3 is very effective for this purpose. The light touch is a matter of practicing the following technique. Dip a No. 1 artist's brush in the powder, shake excess off; then holding the tip of the brush about 6 inches above the glass and transparency matting surface, snap the brush sharply with the thumb and forefinger much as you would in shooting marbles. Practice makes perfect! Too much powder and the illustration becomes noticeably speckled. Too little and there are still Newton Rings.

Cleaning Glass. Another problem common to all glass-mounting systems is cleaning the glass. This is time consuming and generally involves considerable hand labor. Glass-washing machines have been devised but have not proven to be completely successful. The most dependable approach is to soak and wash glass in a cleansing solution, followed by clear water rinse. You then dry with dust-free circulating air or lint-and-wax-free wiping towels. Various agents may be used in compounding the cleansing solution. Detergents of the type recommended for automatic dishwashers, ammonia with water, alcohol with water, and solutions of tri-sodium phosphate are excellent. Less desirable are glass cleaners containing wax and detergents with high wax content. Such cleaners impart a gloss that is very susceptible to abrasions when contacted with wiping towels. Abrasions of this type serve as dust collectors and impair the quality of the projected image.

Glassless Mounts. Mounts made of plastic or cardboard are by far the most popular method of mounting 35-mm slides. They offer advantages such as lower cost, maximum adaptability to projection equipment, no glass breakage, no Newton Ring problems, and easier mounting. The principal disadvantage is the loss of some protection. The side surfaces of the film are susceptible to fingermarks and abrasions when given rough treatment. Under normal circumstances, where the entire slide set is protected in storage boxes or trays, the risk of surface damage is small. Because the advantages outweight the disadvantages, this has become the most popular way to mount slides. Mounts of this type are supplied in several forms. Some typical constructions are as follows:

1. Hinged Type—Where the transparency is positioned in the center of the open mount, the top or hinged flap is brought down over the transparency and the three sides sealed.
2. Two Part—Here the transparency is positioned on the bottom part, a top is placed over the transparency and sealed on all four sides.
3. Insert Type—The mount is presealed on three sides where manufactured. The transparency is cut to size and inserted into the unsealed side of mount which is then sealed.

Exercises (676):

1. List some advantages of using glass mounts.

2. List some disadvantages of glass mounts.

3. What are the advantages of using glassless mounts? Disadvantages?

677. Given statements concerning slide mounting procedures, indicate whether they are true or false.

Regardless of the type of slide mounts you use, there are techniques that apply to each type of slide mounting.

Cutting. The individual transparencies must be cut from the roll unless you are using a slide mounting machine that cuts them automatically. To manually cut your transparencies from a roll, you will need a good light source such as a light box or viewing table, a pair of sharp scissors, and some cotton gloves to wear while you are handling your slides. Always wear cotton gloves to prevent fingerprints on your transparencies.

Hold the roll of film up in front of the light and cut each transparency from the roll. Cut in the center of the black framing lines between each transparency, being careful not to cut into the transparency image.

When mounting more than one roll of film you need a systematic way of doing things to save time and avoid confusion. Do all your cutting first and place the transparencies from each roll into individual stacks. Be sure not to mix up transparencies from different rolls of film. You wouldn't want to have slides of the base bowling team end up in the base commander's monthly status briefing.

Mounting. Now that you have all your transparencies cut, begin mounting them. If you are using cardboard mounts, they will have to be sealed. There are two kinds of cardboard mounts. Some are already sealed on three sides, and others are unsealed on three sides. Before they can be projected, they must be sealed on all four sides after the transparencies are inserted. Both heat and pressure are needed to seal the cardboard mounts. A slide mounting press like the one shown in figure 5-12 does the job very quickly. Just drop your slide and mount combination into the slot on top of the press and depress the footswitch. It will seal the mount on all sides in one operation and drop it into a bin in front of the press.

Semi-automatic Slide Mounters. A slide mounting machine like the one shown in figure 5-13 will both cut and mount your film automatically. The end of the roll of film is trimmed and the roll is lined up in the machine. At the press of a button, the mounter takes over to mount a continuous roll of film in a matter of seconds, stacking the slides in a bin in front of the mounter. These slide mounters use plastic mounts that are specifically manufactured for the machine you are using. Cardboard mounts cannot be used in these mounters.

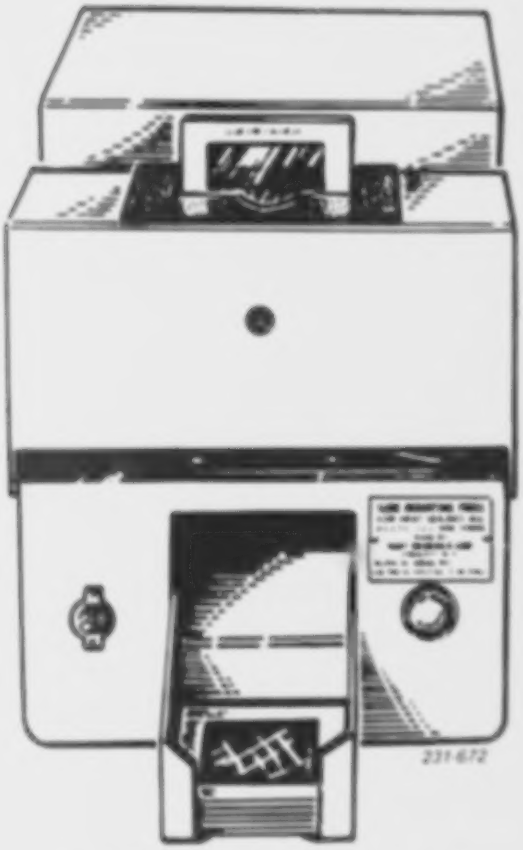


Figure 5-12. "Seary" model III slide mounting press.

Slide Marking. Slide mounts are marked, or can be marked for proper orientation in the slide projector so that they will project properly on the screen and not be backwards or upside down. Typical orientation marks are a dot in one corner or a clipped corner of the slide. If the mount is not marked, you can do this yourself with a pin or pair of scissors after the slides have been mounted. The orientation mark is positioned properly if it is in the upper right-hand corner of the mount while, at the same time, the transparency image is upside down and the film emulsion is away from you. This orientation mark is a useful aid to the person who puts the slides into a tray for projection.

When mounting slides that are classified, the proper classification of the slide must be printed on the slide mount, both top and bottom. This is in addition to the classification marking that is in the transparency image itself. This is important so that the slide can be

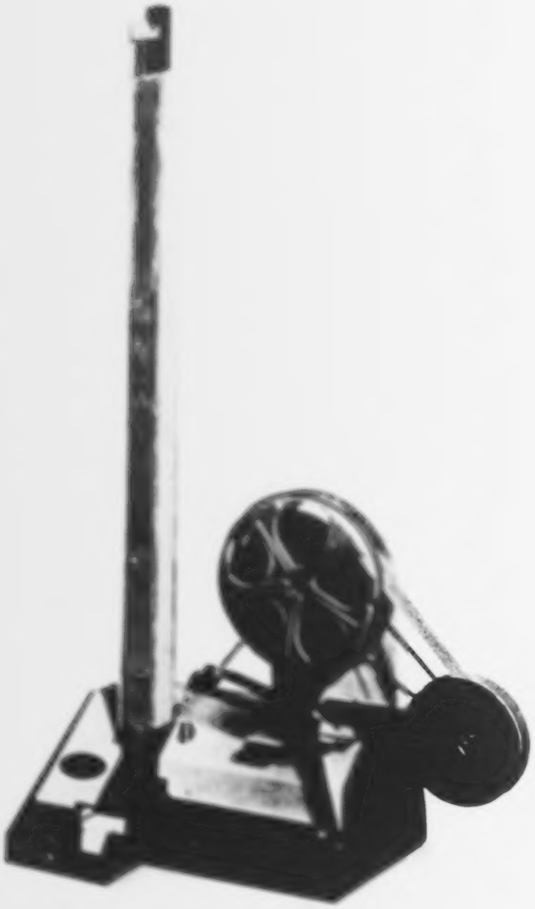


Figure 5-13. "Pakon" slide mounter, model 35.

easily identified without having to be projected. You can use prestamped slide mounts or stamp the mounts with the proper classification after mounting. When using prestamped mounts, be sure that you are using the proper classification and, when stamping your mount after mounting the slides, be sure that you use the proper stamp. Also, be careful not to get ink on the transparency image. Make a final check of all your slides, making sure that they are all properly marked and accounted for before turning them over to the requester.

Slide Quality. The quality of your color slides is best determined *after* they have been placed in individual slide mounts, not while they are still part of the roll. This is because density is difficult to judge when the transparency is not framed by the slide mount. To check for proper color balance, you need a daylight source of light that is also diffused. Most light boxes and viewing tables are equipped with the daylight fluorescent tubes. Make sure that they are so equipped before you use them to check the quality of your slides.

Exercises (677):

Answer true or false to the following statements:

1. Cardboard mounts must be sealed up on three sides before they can be projected.
2. Some slide mounting machines both cut and mount transparencies simultaneously.
3. When a transparency is upright in the slide mount and the orientation mark is in the upper right-hand corner, the slide has been mounted properly.
4. Classified slides are marked with the proper classification in the transparency image only.
5. Any room lighting can be used to check slides for proper color balance.
6. Color transparencies should be checked for proper density before they are mounted.

Quality Control

HOW MANY TIMES have you bought something, taken it home to assemble it, and discovered a piece missing. Despite all of your ugly muttering and comments about the manufacturer's mistake, the fact is you are still missing a part. This happens to all of us. It leads to the statement, "I wonder where the QC man was."

This chapter is dedicated to all of those quality control (QC) people who took a break at the wrong time. In this final chapter we cover cleanliness, evaluation, defects, sensitometry, replenishment, and storage of materials.

6-1. Observing Laboratory Cleanliness

Quality control begins with laboratory cleanliness. If you feel that laboratory cleanliness is not important, ask yourself whether or not you would want a doctor to operate on you with a dirty scalpel, whether you would want a service station attendant to put into your automobile gasoline that was full of dirt, or whether you would want a furniture repairman to polish a fine piece of your furniture with a greasy polishing rag. Of course you wouldn't. Neither would you want to work in a dirty laboratory. All the care you may employ in processing is totally wasted if your solutions are contaminated with foreign particles which adhere to the surface of the film. What good is film if it has a full-length scratch caused by a chemical deposit. The purpose of laboratory cleanliness is to prevent a loss of quality from conditions in the laboratory.

678. State principles and techniques of laboratory and equipment cleanliness.

If you were to examine some of the many publications covering the subject of photography, you would notice that they often include a section on defects. A close examination of these lists of defects would show you that a large portion are caused by a lack of laboratory cleanliness.

Some photographic techniques are even built around the concept that the defects can be corrected. For example, print spotting is often accomplished in order to remove white or gray marks caused by dust, lint, or even chemical dust. Rather than correct the defect, it is preferable to eliminate the cause. And the causes can be numerous.

Equipment Storage Room. Check the camera case and its contents for dust, lint, etc. The camera, when stored, should have been put away in its case. If the lid of the case is closed, so much the better. As a precaution, carefully dust the camera and pay particular attention to the lens. Especially check the lens for fingerprints. If someone handled it carelessly, they may have smudged it with oily fingerprints. These prints are bad enough in themselves as far as reducing photographic quality; but since fingerprints are somewhat oily, they will catch and retain more dust particles than an unmarked lens. A lens in this condition must be cleaned before use.

Carefully examine all the camera accessories and make sure they are clean. If an exposure meter is to be used, make sure it is zeroed and that the photocell glass is clean. Check all accessories in a similar manner to assure efficient operation.

In many cases it is advisable to make sure that dust is not present in the camera interior. During operation, this dust could be loosened and deposited on the film. If you are using cut film, make sure holders are clean before loading. Use a brush designed to eliminate static electricity. Any dusting operations should be carried out in an area of the lab that is relatively clean, but not in the loading room. If you clean your equipment in the loading room, chances are that the dust will rise into the air and then settle back on both the film and the equipment you just cleaned. A room used for the dusting operation should be well ventilated or be equipped with some means of dust removal.

Film Loading Room. If possible, a room should be set aside to be used only for loading film. Such a room should be kept as clean as possible and free of all dust. The biggest advantage of using a special loading room over the usual processing or printing room is that the loading room is free of chemicals. Remember, the room should be used for only this one purpose-loading film-not for storage, extra processing facilities, etc.

If you are forced to use some type of processing lab for loading, be especially careful of chemical contamination. Whether the lab is used for contact printing or negative processing, the fact remains photographic chemicals will be in evidence. Consequently, cleanup procedures must be rigid. You will save considerable effort if the lab is maintained with a wet side and a dry side. The dry side is always dry. Absolutely no solutions or chemicals should cross the imaginary line down the middle. Even with these precautions, carefully inspect the area you will be using for loading for any evidence of chemical deposits. Also, be careful of any water that might have splashed on the loading area. Take all the necessary precautions in providing yourself with a clean loading surface.

Mission Accomplishment. The moment you go out on a mission you are exposing your film holders, film pack adapter, or other film containers to a dusty and dirty environment. Keeping the holders clean during the mission is largely a matter of common sense. Don't lay them down in the dirt or on any surface that increases the chance of their becoming exposed to any form of matter which can enter the holder. Not only should the holders be protected, so should the camera and related equipment. Many of the precautions to be taken are obvious. Also, look for the not-so-obvious situations where particles of foreign matter are present.

Unloading and Processing. This is one of the most critical stages of handling film since the film is in an area that more than likely is used for both unloading and processing purposes. Film should be afforded the same treatment during unloading as when it was loaded. Before unloading, thoroughly clean the unloading space. If you dust it off, use a rag that will pick up the dust rather than simply causing it to become airborne. If there is a possibility that chemicals may be present on the loading surface, wipe the surface with a damp rag or sponge in order to remove the chemicals. Then let the surface dry before proceeding with the unloading process. Make certain that the sponge or rag you are using for this purpose is clean and has not been previously used to wipe up hypo or some other chemicals. The use of a dirty rag will not help matters.

If you are going to delay processing till later, be sure the container used to store the exposed but unprocessed film is clean. Use of the original film box is advisable, but only if it has been kept clean since you removed the unexposed film.

If you are going to process the film at this time, you should have already checked the wet side of the lab for clean trays and associated equipment before mixing the working solution of developer. Many times, a lab may not have been used for a considerable length of time. If this has happened, the trays may have collected dust. Also, check the tray of hypo. It may have been left full for economy reasons, but if stored in this manner for a considerable time, it could be dirty to the extent that it should be discarded. False economy here could ruin your negatives, and it would certainly be cheaper to prepare a fresh batch of this inexpensive chemical.

Negative Drying. After you have developed, fixed, and washed your negative, it must be dried. This is a fairly critical step. You could drop a wet negative on the floor, rewash it, and still end up with an acceptable product. However, if you hang a negative to dry in a dusty atmosphere and the particles of dirt adhere to the emulsion until it is dry, no amount of additional washing will remove them. If the negatives are hung on a line to dry, the entire room must be kept clean. If at all possible, use a drying cabinet that can be heated to speed up the drying process and one that circulates filtered air to eliminate as much dust as possible. The sooner the negatives are dried, the less chance there is of dust sticking to the emulsion.

After the negatives have been dried, they must still be protected. In general, the protection from this point on is not quite as critical as before. Negatives should be placed in separate negative preservers as a protection from dust, scratches, etc. If more than one negative is to be placed in the preserver, a sheet of protective paper must be placed between negatives. This paper will keep the negatives from rubbing against each other which is a primary cause of abrasion marks. By all means, do not allow fingerprints to remain on the surface of the negatives. If the fingerprints are cleaned off immediately, they are readily removable. If they have been on for some time, they may be difficult, if not impossible, to remove.

Cleanliness During Printing. During this stage of the photographic operation, you will find many situations where cleanliness saves much additional work. The first consideration should be given, as mentioned before, to maintaining a wet and a dry side in the laboratory. The area of the lab used for printing, whether projection or contact, must be kept clean and dry. During the printing operation, much unexposed and exposed material will be laid out on, or alongside, the printer. If water or chemical solutions have splashed on these surfaces, many of your prints will be spoiled before they are even processed.

After you have processed your prints, your hands may be moistened with either water or one of the chemical solutions. If it is just water on your hands, simply dry them off on a clean towel, not one previously contaminated with chemicals. If your hands are wet from contact with the hypo or developer, wash them off with clean water before using the towel. And be sure you dry them before returning to the dry side of the lab.

Another point to watch when using the wet side of the lab is to avoid all chances of splashing any of the solutions during processing. If you splash, the solutions will get on the floor and on your clothing. Thus, the solutions can be transported to the dry side. If hypo is on your clothing, you may accidently ruin the print. If solution falls to the floor, the effects are not quite as noticeable, at least at this time. However, you will track the hypo or other solutions around the floor where they will dry. After the chemicals are dry, they assume their original powdery form. As you walk back and forth, you stir up these chemicals, and they become airborne, eventually to fall back on all flat surfaces. Some of the flat surfaces could be film and paper. If you find a number of pinholes (especially noticeable in dark backgrounds) on your negatives, this could be the cause. The same type of markings would also be noticeable on prints.

Laboratory Cleanup. An important factor in quality production is the general state of cleanliness in the laboratory. From time to time it may become your job to clean the lab. The use of a broom to sweep the floor is not advisable. Rather, use a dust-mop type of sweeping device that will not throw dust and chemicals into the air. Following this operation, a wet mop should be used—rinse and wring it out frequently. The use of a dirty mop will do more harm than good.

Sinks should be well-rinsed with clean water in order to remove all traces of chemicals. Edges and back panels that cannot be flooded with water should be wiped with a clean damp rag or sponge. Water is cheap at any price when the lack of its use can damage your product.

During a general lab cleanup, do not forget to clean chemicals from walls, bottles, graduates, timers, and other equipment. Chemicals from the handle of a timer or a wall could easily transfer from such a surface to your hands and then to a negative or print. At the same time, check the safelight filters. Chemical deposits here could contribute to decreased illumination along with other ill effects.

After a lab has been generally cleaned, it is advisable to use a vacuum cleaner to remove dust that has settled into corners of the room and other areas often missed during usual cleaning. If a vacuum cleaner is available, use it to remove the dust and lint from items of equipment in the lab. From time to time use the vacuum cleaner to clean the inside of a contact printer, for example. Removal of dust from this area may save you a reprint caused by the deposit of dust or lint on a negative or print.

The ideal situation in a laboratory would be to have it in a surgically clean state. Since this is not possible, strive for maximum cleanliness. Track in as little dirt as possible, be as clean as you can in your operations and avoid splashing chemical solutions, provide for regular cleanup sessions, maintain dry and wet sides, and use a room for its intended purpose. Cleanliness in photography is just as important as correct technical procedures.

Dust can raise havoc in any photographic process from the beginning to the final product. Dust often contains small particles or crystals of quartz—such particles can readily scratch glass surfaces such as printer glasses, lenses, etc. When cleaning critical surfaces of this type, be especially careful that you use the proper kind of cleaning material. If you rub quartz particles into the surface as you are cleaning, you take the chance of scratching it. It may be necessary to dust the surface lightly with a fine-haired brush or use a gentle air jet from a hand syringe prior to cleaning off the fingerprints, etc.

If a liquid is required to complete the cleaning job, remember that water will eliminate most chemical deposits. When it is necessary to use a solvent other than water, use as little solvent as possible and consider all safety precautions connected with its use. Never soak a piece of equipment in the solvent. The use of an excessive amount may prove to be more damaging than if the item were left uncleaned. For example, cleaning a lens by soaking it with alcohol will remove the fingerprints, but it may also separate the lens elements. Or the excessive use of solvents on a tiled laboratory floor may loosen the tiles after repeated applications.

After you have done as much as you can with respect to maintaining the cleanliness of a laboratory, you have gone far down the road of quality control. Even so, dust, chemicals, lint, etc., will still be a problem. If so, the next section covering visual quality control will serve as another check on cleanliness.

Exercises (678):

1. Why should you avoid cleaning your camera equipment in the loading room?

2. Describe the dry side of a lab.

3. How should down-loaded film be stored?

4. What happens to chemicals when they are splashed on the floor?

5. How much solvent should you use to clean any item?

6-2. Employ Visual Evaluation

While it is not truly scientific, visual examination can greatly improve the quality of your work. By checking your negatives, slides and prints for proper density, contrast, and absence of defects, you can identify what you are doing right and where your problems are coming from. Remember, if you can't look at your own work and take pride in it, you can't expect the requestor to think much of it either.

679. Given a list of print or negative defects, identify the cause of each one.

Visual Examination. The key to visual examination is to have an appropriate check list and a consistent viewing standard. For example, you may develop a list that covers density, contrast, sharpness, and mechanical (pinholes, scratches, etc.) and chemical (stains, etc.) defects. You then follow a consistent viewing pattern. You should always look at your negatives, slides, or prints, using the same light table or viewing light, etc. Only in this way can you have a consistent basis for making a judgment.

What to Look For. First you should look at the density of the product. Too much exposure produces negatives that are too dense, prints that are muddy, and slides that are thin. Too little exposure leads to thin negatives and prints and saturated slides. How about the contrast? There should be detail in both the highlights and shadows unless you are going for a special effect. Negative contrast is a product of development, so if your negatives are too contrasty, you might need to cut your development time. If they are too thin, you must increase the development time. The contrast of prints can be altered through choice of paper grade, filter, or, to a limited degree, development. Slides, unfortunately, can only be corrected by copying, which normally results in a product that is slightly inferior to the original. Sharpness is a product primarily of your focusing. It is too late if your negatives or slides are off. If you have a soft print, you can reprint. Consistently soft results should cause you to check your equipment or your technique! Finally, there are innumerable mechanical or chemical defects caused by defective cameras, accessories, improper handling, or contaminated chemicals. The following is a sampling of what you might encounter:

a. The image appears hazy and lacking in contrast.

(1) The sun was shining into the lens. Remember, it is necessary to protect the lens from the direct rays of the sun when you take a photograph against the light. Light striking the lens causes a hazy, indistinct image. Sometimes, bright light striking the lens produces large circles which partially obscure the image.

(2) Your lens is dirty. Many times, dust or condensed water vapor on the lens results in hazy pictures. Remember to clean your camera lenses frequently.

(3) Overexposure.

(4) The negative is fogged.

b. You observe small transparent and irregularly shaped spots. This is often caused by dust settling on the film before the exposure. It can be corrected by cleaning the camera interior and by loading the film in a clean environment.

c. Small circular transparent spots. These are produced by small air bubbles on the surface of the film during development. This problem can be taken care of by proper agitation.

d. When a negative emulsion has a wrinkled appearance (reticulation)—this is produced by an abrupt or sudden swelling or contraction of the film. Sharp differences in the temperatures of successive processing solutions and/or insufficient hardening of the gelatin are the usual causes of reticulation.

e. The image is not sharp.

(1) The subject moved. If this is the case, any stationary objects included in the picture will be sharp, assuming that they are in focus. Lack of sharpness will be confined to the parts that were in motion at the time of exposure.

(2) The camera moved. If this is the case, there is a general blurring of the image. Sometimes, you will observe double lines made by the subject. Remember that the average photographer cannot hold the camera perfectly still for an exposure longer than 1/30 second.

(3) The subject is not in focus. If other parts or objects of your negative are sharply defined, while objects at other distances are not sharp, the camera was not set for the proper distance. You made an error in using the rangefinder, focusing on the ground glass, or selecting the correct focusing distance on the distance scale.

f. Dense areas of varying width along the edge of the negative—this condition is produced on roll film when the film is not tightly wound upon loading or removal from the camera.

g. The image on your negative is partially a positive. This is due to reversal of the image and is sometimes caused by hypo in the developer. More often, it is the result of a brief exposure to light during development.

h. A yellow stain appearing after the negative is dry—this may be caused by insufficient fixation or the use of an exhausted fixing bath. Small yellow or brownish spots are due to air bubbles on the film during fixing.

i. Pink stains are due to traces of the dye applied to the back of certain films for the purpose of preventing halation. The stains can often be removed by placing the film in a 5-percent solution of sodium sulfite after washing. The film should then be returned to the wash for an additional 5 or 10 minutes. If the negative is dry, it should be allowed to soak in water for 10 to 15 minutes before being placed in the sodium sulfite solution.

j. Blisters or circular pits in the emulsion when viewed from the surface—the blisters may be produced by concentrated developing solutions, developer or fixing solutions which are too warm, insufficient rinsing between developing and fixing, or an old or incorrectly compounded solution.

k. Grayish whites over the entire print are usually caused by chemicals or light fog. They also may be caused by insufficient potassium bromide in the developer, too long a development time, or the use of outdated paper.

l. A grayish-mottled or granulated appearance of the edges or entire print is usually caused by underexposure and forced development. This effect may also be caused by using outdated paper. Moisture within the paper or exposure to chemical fumes, such as ammonia, can also produce this effect.

m. A purple discoloration of the print is caused by lack of agitation in an acid stop bath.

n. White deposits over the entire surface of a print are caused by milky hypo baths and incorrectly mixed or impure chemicals.

NOTE: The above is not an inclusive list of negative and print defects. Most manufacturer's of photographic materials and chemicals have charts listing defects and their causes. Such lists are very helpful as you strive to produce top quality work.

Exercises (679):

1. Identify the cause of the following defects.
   a. Thin slides.

   b. Muddy prints.

   c. Hazy negatives.

   d. Negative has wrinkled appearance.

   e. Negative is partially positive.

   f. Small yellow or brownish spots on the film.

   g. Grayish whites on your print.

   h. Purple discoloration to the print.

6-3. Solution Certification

Suppose you had 30 sheets of film that were very important and could not be reshot. How can you be sure that, when you process them, they will come out properly? You might mix new chemistry or process by inspection. But how will you know beforehand that the new chemistry is good or that the safelight will not fog the film? What you need to know is whether the processing solutions are working properly.

The best method of ensuring that your process is in control is to certify your chemistry.

680. Given a list of specific gravity readings, match the readings to the solutions.

The first check that should be made on all solutions is a specific gravity reading. It is a quick check to see if the mix is complete. Specific gravity is the ratio of mass of a given volume of substance to an equal volume of distilled water at 60° F.

$$\text{Specific Gravity} = \frac{\text{Mass of a known volume of a substance}}{\text{Mass of an equal volume of water}}$$

Specific gravity readings will vary from one batch of solutions to another because of various factors involved (quality of chemicals, inaccurate scales, etc.). This requires that upper and lower control limits be set. If the solution does not fall within these control limits, further analysis can be made to determine the cause. If the specific gravity reading goes beyond the upper control limits, it might indicate that more than the formula amount of an ingredient has been used or the solution has not been diluted properly. A reading which is below the lower limits might indicate that an ingredient has been left out of the solution or that too much water has been added.

For practical purposes the hydrometer is generally used to calculate specific gravity of liquids. The hydrometer is calibrated to read 1.000 in pure, distilled water at 60° F. A temperature change will have a direct effect on the specific gravity reading. For every increase or decrease of 5° F, 0.001 must be added or subtracted. Research indicates that the temperature corrections for most photographic solutions whose specific gravity falls between 1.100 and 1.200 is very close to 0.003 per 10° F temperature change.

Specific gravity readings using a hydrometer require that the hydrometer cylinder be on a level support. Readings are taken at the top of the meniscus as seen along the side of the hydrometer stem (see fig. 6-1).

The following are sample specific gravity readings for solutions that you are likely to use each day.

Solution	*Specific Gravity*
DK-50	1.034
D-76	1.084
D-72	1.105
HYPO	1.074

Exercises (680):

1. What is the purpose of a specific gravity reading?

2. Select from the list of specific gravity readings in column A, one reading appropriate for each solution in column B.

Column A	*Column B*
(1) 1.075.	a. D-72.
(2) 1.100.	b. D-76.
(3) 1.050.	c. HYPO.
(4) 1.090.	
(5) 1.001.	

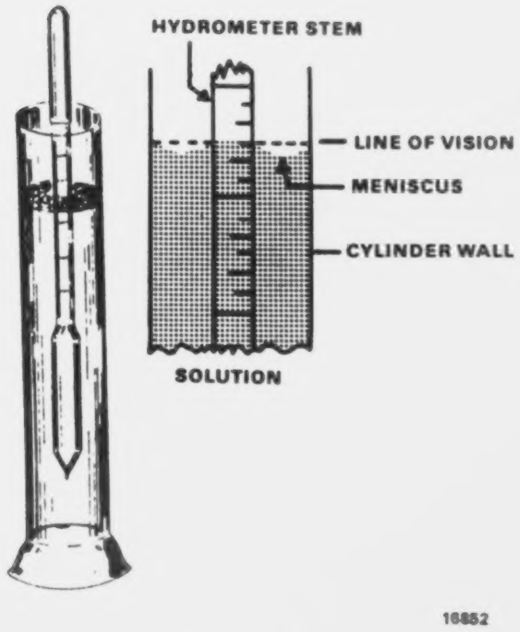


Figure 6–1. Hydrometer.

680a (687—for CE feedback reference only). List the methods for determining pH.

Specific gravity is the first and quickest test given to a photographic solution. However, even if the solution has the right specific gravity, it must not be assumed that it will perform as desired. The alkalinity or acidity of a solution will also affect its ability to process photographic materials. The amount of alkalinity or acidity is determined by measuring pH.

The pH of a solution can be described as a measure of its alkalinity or acidity. pH values have a scale of zero to 14, with 7 being the neutral point of pure water at 77° F (25° C). This measurement can be used as a factor for control of replenishment or to determine when to dump the solution.

There are two common methods of determining the pH of a solution: (1) through the use of various pH indicators and (2) through the use of a pH meter.

pH Indicators. Most common indicators change color under different conditions of pH. Although no one indicator can determine pH throughout the entire pH scale, specific pH can be obtained through the use of several indicators. A common pH indicator is litmus paper. Litmus paper comes in two colors: blue litmus—which changes to red when an acid is sufficiently concentrated—and red litmus—which turns blue when an alkali is sufficiently concentrated. The litmus test is not infallible, since it will not detect acids or alkalis near the pH value of 7.

pH Meter. Basically, a pH meter is a device which measures electrochemical potential. To perform this function, the pH meter is composed of many subsystems including the electrodes, which generate a minute electrical potential. It also includes an amplifier to amplify the minute potential from the electrode and a scale to indicate the pH of the solution.

When making a pH measurement, the electrodes are first immersed in a buffer solution. A buffer is a solution whose exact pH is known. The meter is calibrated so that the reading shown is the exact pH of the buffer. Following the calibration, unknown pH values will be a direct readout when the electrodes are immersed in the test solution.

Normally, there are three buffers in the lab: pH 4, pH 7, and pH 10. For accuracy, always select the buffer that would correspond closest to the pH of the solution being tested. For example, when testing developers, use buffer 10; and with fixing baths, use buffer 4.

Exercises (680a):

1. List the two methods of determining pH.

2. What is a buffer solution?

680b (688—for CE feedback reference only). Describe the application of sensitometry to quality control and the operation of a sensitometer.

Sensitometry is the science of analyzing the effects of exposure and processing on photographic material. The shortest definition of sensitometry is standardization. That is, if you process your film following set procedures and compare your results against a known standard, you will always produce acceptable results.

Suppose you processed those 30 sheets of film we talked about earlier and they were all blank. Obviously the photographer is going to claim that it was your processing that was at fault. And just as likely you are going to suggest that the photographer forgot to pull the dark slide. The point of sensitometry is to eliminate as many of the variables as possible.

If you had processed a piece of film, along with the 30 in question, that you absolutely knew was properly exposed, you may have eliminated processing as one of the variables. You may also have pinpointed the processing as being at fault.

If this extra piece of film you processed came out properly, you know that the chemistry is not at fault. Had the piece of film also been blank, you could safely assume that the processing was at fault.

To produce this piece of film with the known exposure, you would use a sensitometer. A sensitometer (fig. 6-2) is a device used to produce controlled known exposures time after time.

There are two important qualities that a sensitometer must have: (1) a light source and (2) a device to produce a series of graded exposure steps. The light source must make the time of exposures correspond to actual photographic practice, and remain constant. The exposure time (10^{-2}, 10^{-3}, 10^{-4} sec) used for the test strip should be one that is in the range recommended for the type of photography that will generally be made.

Intensity scale sensitometer. When film is exposed in a camera, a shutter opens for a predetermined period of time and closes. We say that the film has received an exposure. But, in reality, it has received as many exposures as there are different tones in the scene. Thus, the camera exposures are said to be intensity modulated. The most commonly used intensity scale modulator is called a step wedge or step tablet. It is made by exposing photographic film with a series of geometric progressing exposures and developed in developer that produces densities as free as possible of color other than gray. Step wedges are available in 11 or 21 steps of varying densities that progress in .30 and 0.15 logarithmic values. The values of the grade exposure steps must be accurately known and arranged in steps increasing from low to high.

The Mark VI Sensitometer (fig. 6-2) is an example of an intensity scale sensitometer. This instruments produces precise 10^{-2} (1000MCS), 10^{-3} (5000MCS), and 10^{-4} (130MCS) second duration flashes. The Mark VI has light outputs sufficient to test the slowest speed and fastest emulsions, and flash durations which approximate the exposures encountered in snapshot, electronic flash, and high-speed motion picture photography.

For studies of film characteristics such as contrast, speed, and fog, the sensitometer is used for generating "characteristic" curves for the particular film of

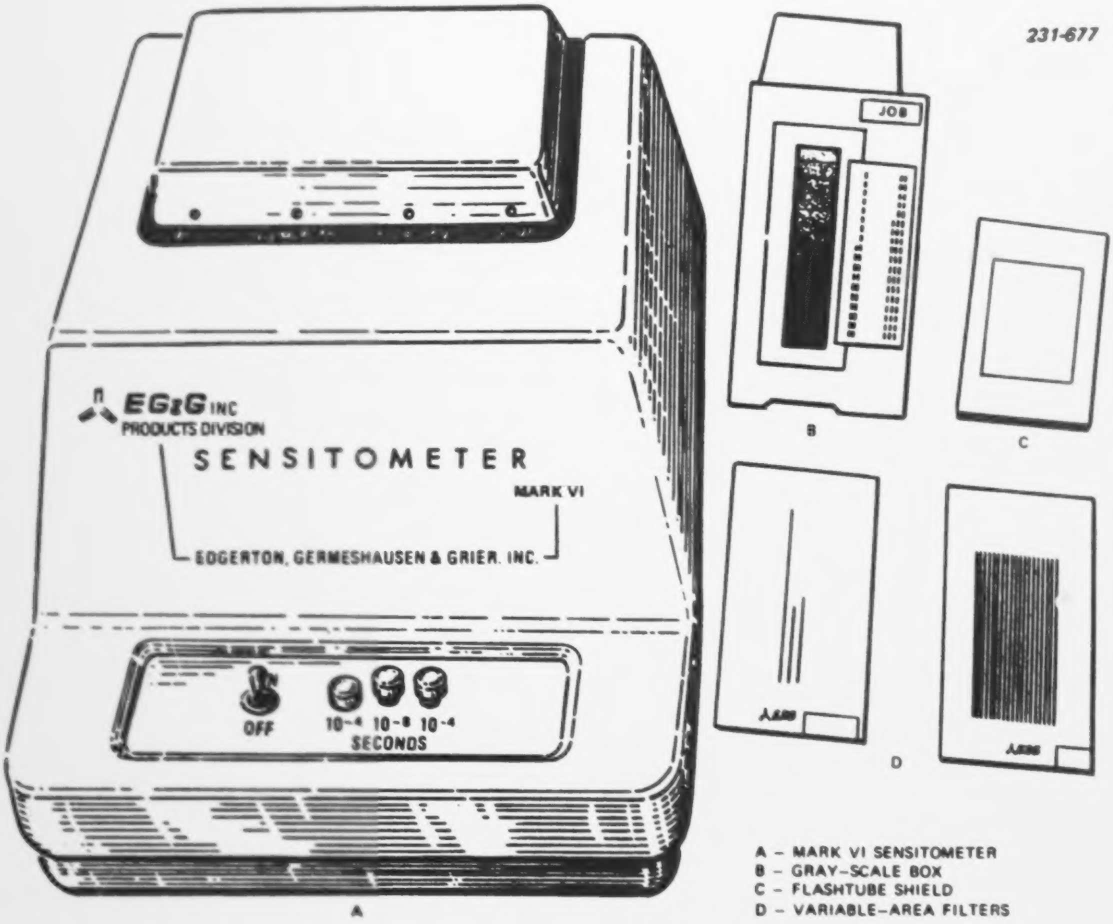


Figure 6–2. A sensitometer.

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interest. This should be done using the manufacturers' recommended exposure and developed schedule.

To operate the Mark VI, follow these steps:

(1) Plug power cord into an outlet. Be sure to ground the plug to prevent shock hazard.

(2) Switch the power on.

(3) Press exposure circuit selector button for desired flash duration.

(4) Add filters or light attenuators if necessary.

(5) Turn the room lights off.

(6) Place film to be exposed over the step tablet, emulsion down.

(7) Slide film into proper groove.

(8) Hold the film in place at one end and lower the platen onto the film.

(9) Pull arm down until clicking sound indicates that the tube has flashed.

(10) Process film as usual.

Exercises (680b):

1. Sensitometry is the science of analyzing the effects of ____________ and ____________ on photographic materials.

2. The one-word definition of sensitometry is ____________.

3. Why is sensitometry applicable to quality?

4. Which of the following is not an operation of the Mark VI sensitometer?
   a. Select the desired exposure flash setting.
   b. Add filters or attenuators?
   c. Adjust the calibration control until the meter reads the density required.
   d. Slide the film into the groove and lower the platen onto the film until a clicking sound has indicated that the flash tube has fired.

680c (689—for CE feedback reference only). Identify the procedures for operating a densitometer.

After you have produced a sensitometric strip and processed it, your next step is to measure the density of the individual steps. Density is the logarithm of the reciprocal of the light transmittance, stated D=log 10(l/T). The densitometer uses this method and gives values that (1) give numbers that increase in size and the silver deposit increases in density and (2) corresponds to the way the eye sees light intensity differences.

Most Air Force laboratories use direct reading, electronic densitometers. The MacBeth Quantalog Densitometer, TD–102, shown in figure 6-3, is typical of the kind of instrument that is generally used. It may be operated under any normal lighting condition, since ambient light does not affect its optical system. The instrument is equipped with a turret containing four filter positions. The filters installed in the turret are the red, Wratten No. 92; the green, Wratten No. 93; the blue, Wratten No. 94; and a No. 106 for visual operation. For color densitometry, you use the three colored filters; for black-and-white densitometry, place the turret in the visual position.

Except for minor differences, all densitometers are used in the same manner. To operate the TD–102 densitometer, you must first zero adjust the instrument. To zero adjust the TD–102:

(1) Rotate the zero-adjust knob to turn the power on, after the instrument has been plugged into a suitable power line whose voltage is stabilized.

(2) After a 30-minute warmup, with no sample in place, rotate the filter selection control (the gold filter trim control to the bottom position), and depress the snout lever. Turn the zero-adjust knob further clockwise until the needle is properly zeroed. These steps can be repeated for red, blue, and green when zeroing in for color work.

To calibrate the TD–102 after zeroing:

(1) Place the internal calibration reference in the measuring beam by moving the calibration reference lever backwards until you feel it "click in."

(2) Depress the snout lever.

(3) Adjust the calibration control until the meter reads the density indicated on the tag adjacent to this control.

(4) Remove the internal calibration reference from the measuring beam.

(5) Recheck your zero and calibration settings.

NOTE: Fine needle adjustments can be made by rotating the filter trim control knob that is in the bottom position.

Once you have determined that your densitometer is in calibration and is operating correctly, you are ready to make density readings of your sensitometric strips. Readings are made by lowering the snout lever down on each step of the processed sensitometric strip and recording them in proper sequence.

Exercises (680c):

1. A ____________ is a device used to measure the densities of a piece of film.

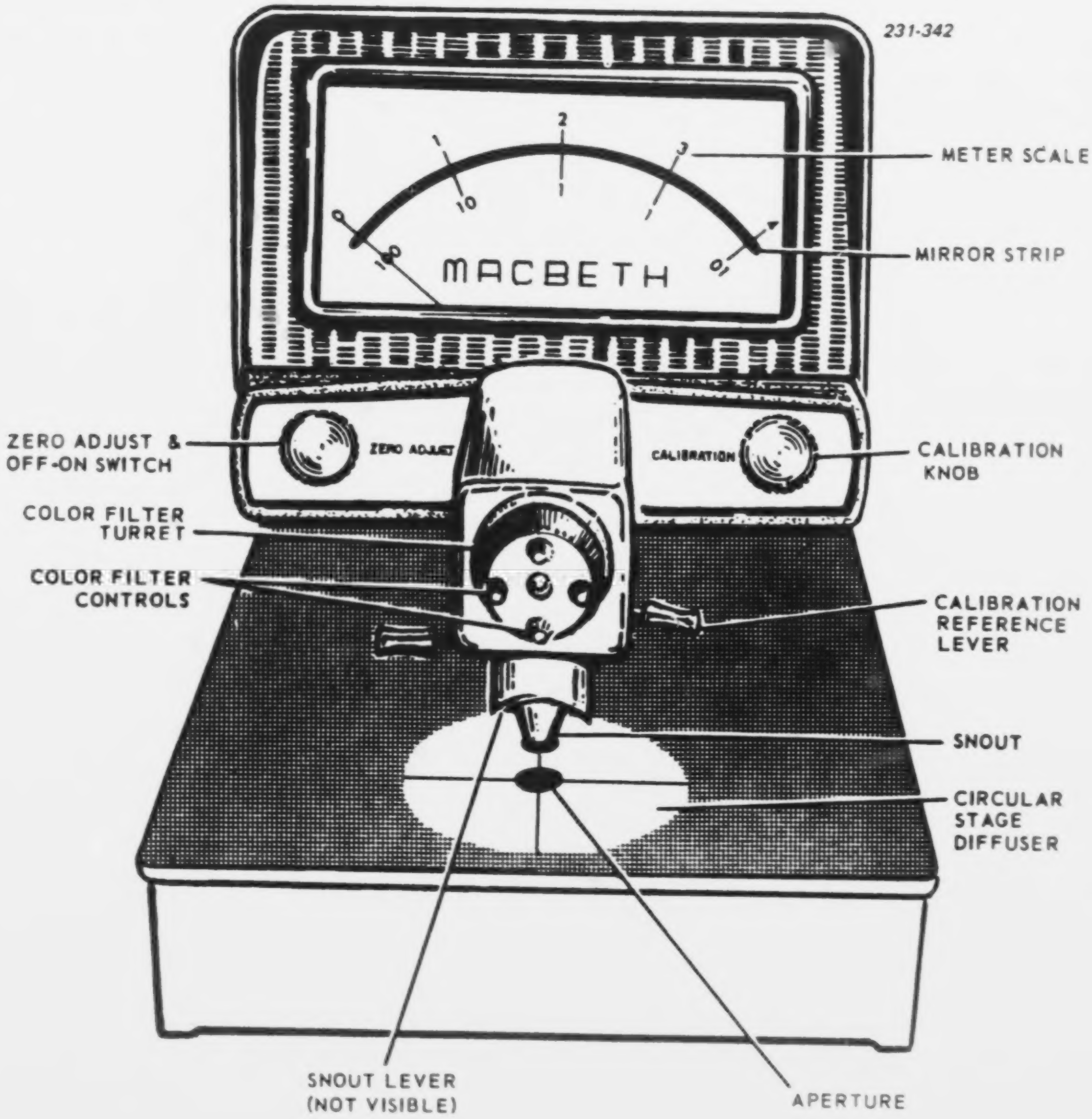
231-342
MACBETH
METER SCALE
MIRROR STRIP
ZERO ADJUST & OFF-ON SWITCH
ZERO ADJUST
CALIBRATION
CALIBRATION KNOB
COLOR FILTER TURRET
COLOR FILTER CONTROLS
CALIBRATION REFERENCE LEVER
SNOUT
CIRCULAR STAGE DIFFUSER
SNOUT LEVER (NOT VISIBLE)
APERTURE

Figure 6–3 A densitometer

2. From the following list, identify which procedures are required to make *readings* of a black-and-white sensitometric strip on the TD-102 densitometer.
   a. "Click in" the calibration reference lever.
   b. After a 30-minute warmup, rotate the filter selector to the visual position.
   c. Rotate the gold filter trim to the bottom position.
   d. Depress the snout and adjust the zero control until the meter reads the density indicated on the tag.
   e. Place a calibrated sample over the aperture.
   f. Depress the snout lever and record the readings.

680d (690—for CE feedback reference only). Given a process control chart, determine if a process is within control limits.

Now that you have learned how to make pH and specific gravity readings, you must be able to use them to determine facts about the process. The process control chart is an abbreviated graph that visually shows what your process is doing.

A control chart is a progressive line graph used for recording and charting data. It consists of two axes and three lines (see fig. 6-4). The first, or horizontal, axis may be marked off in periods of lines, frequencies, or in some other way. The vertical axis is marked off in whatever units you may be using in the measurement of the sample. It may be gamma, pH, density, or other units of measurement. The one line above or below the horizontal axis in the process limits. Generally, control charts are marked off into days of operation, but any time or frequency can be used.

To learn how control charts are used, let's assume that you are keeping records on pH determinations of samples taken from a film processing machine. A reference point, an average mean or number determined to be constant after a series of readings, has to be established. This point is usually found after performing from 5 to 15 tests on a given solution. It is well to note that a manufacturer of chemicals will not furnish you with an established reference point because of variables found in the photographic process.

Once you have established a mean point, you may construct the chart, using standard graph paper (20 lines/sq in). Draw a horizontal line on one of the accented lines. Label this line your average mean (ave.). Then draw two more horizontal lines—one labeled upper control limit (UCL) and the other lower control limit (LCL). The placement of these two lines on the chart is determined by the tolerance limits for your process (i.e., specific gravity 0.010, pH 0.20, and gamma 0.10).

Anytime two or more reference points are entered on your chart, a line is drawn between points. If the reference points exceed the UCL or the LCL, a new mix is indicated.

Small changes in control plots are normal, but the plotted points must remain within tolerance limits. If your points plot outside established tolerance limits, corrective action should be taken to bring the plots within limits.

Exercises (680d):

1. Is the process depicted in figure 6-4 in control?

2. Define UCL and LCL.

3. When process points are plotted outside the UCL and LCL, ____________ ____________ should be taken.

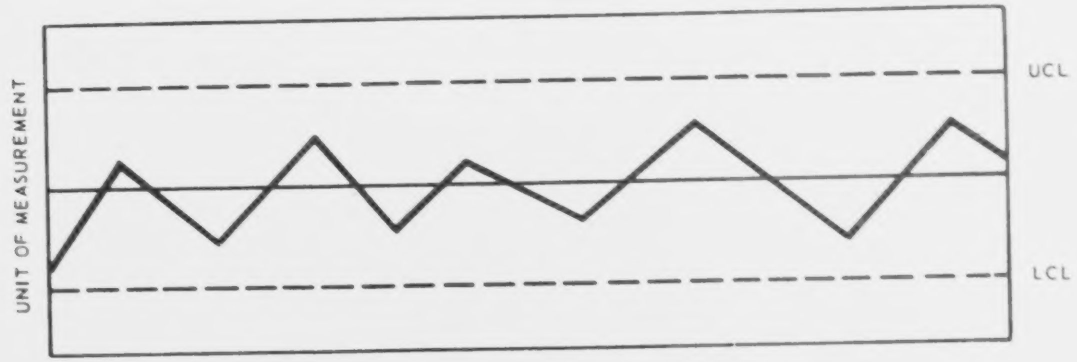

Figure 6-4. Typical control chart.

6-4. Replenishment

Through use or just through age, photographic solutions lose some of their abilities to perform that they had when they were freshly prepared. Physical changes take place whether or not the chemicals are actually used to process photographic materials.

In this section we discuss the physical changes that photographic solutions undergo through use, how to detect these changes, and different methods of replenishment that can be used.

681. State the principles and procedures related to the replenishment of developers.

Some of the factors that alter the characteristics of photographic solutions are: loss of solution through solution carryover, oxidation through use or from improper storage conditions, chemical reaction through processing of sensitized materials, and dilution also caused by solution carryover.

For many labs, the gradual loss of a solution's processing abilities is no big problem because allowances can be made by increasing processing times and the relatively small batches of chemistry can be discarded and new chemistry mixed if things get too far out of hand. However, many large photo labs use large volumes of solutions, especially in machine processors where "dumping" of the chemicals (when they no longer meet standards of processing) would be highly impractical as well as expensive. Here, replenishment of solutions to revive them and make them work properly is very important. Chemistry replenishment is economical and also saves the time it would take to remix solutions each time they were not performing properly.

Effects Resulting From Use of Developers. With use, the activity of the developing solution changes. The used developer becomes slower in its reaction; and as a result, a longer development time is needed to achieve the same result. There is an effective loss of film speed as the developer deteriorates. The change in the activity of the used developing solution is the result of chemical changes that take place within the solution.

Chemical changes in the developer are the result of the following:

- Chemical reaction of the developing solution with the silver halides of the emulsion.
- Action of the air upon the solution (oxidation).

- Loss of solution through carryover to the following tank.
- Dilution of the developer (when a predevelopment bath is used). The most significant of the chemical changes are those caused by the chemical reaction of the developing solution with the silver halides and the air.

As the developing solution reacts with the silver halides, metallic silver is formed in the emulsion and complex reaction byproducts are formed in the developing solution. The most significant of these reaction byproducts are the bromides and iodides. The reason they are significant is that they have a restraining effect on the developing agent. The developer-silver-halide reaction tends to cause the pH of the developer to drop.

The reaction of the developing solution with the surrounding air creates unuseful and unavoidable oxidation byproducts. Oxidation of the developing solution tends to raise the pH of the developing solution. The reason the pH tends to rise is that sulfonates are formed as a result of the oxidation process, and these sulfonates are alkaline.

In addition to the depletion of the developing agents, there is a simultaneous depletion of the alkali and sulfite. However, the restraining action of the iodides and the bromides which accumulate in the developing solution is more significant than the reduction of developing agent, alkali, and sulfite.

Detection of Developer Deterioration. You cannot detect the degree of exhaustion of the developing solution just by measuring its pH. The pH is lowered by reaction between the developing agents and the silver halides, but it is raised by the reaction between the developing agents and the air. Nor can specific gravity measurement by itself provide you with much useful information about the used developing solution.

You can check the deterioration of the developing solution through detailed solution analysis. In such a procedure, you must analyze the solution for Metol, hydroquinone, bromide, sulfite, and carbonate content. Through this type of analysis, you get exact information about the degree of deterioration.

If neither pH measurement nor specific gravity measurement can give a concrete indication of solution deterioration, and complete analysis of the developing solution is not practical, how can you detect deterioration of the developing solution? One of the easiest methods for doing this is to monitor the results that are produced by the solution by using sensitometric methods and using them frequently.

If you process sensitometric control strips when the solution is fresh and while processing, you will be able to spot any significant changes in the solution.

If you have serious doubts about the quality of a given solution, you can always process a control strip by itself to verify the adequacy of the solution. This will avoid possible damage to critical film.

To determine solution performance, you compare the results of characteristic curves prepared from the tests made in used solution with the characteristic curves prepared when the solution was fresh. Changes in the characteristic curves are normally used as the basis for determining when the developing solution is no longer adequate.

Developer Replenisher. Not only must the replenisher solution add chemicals that have been used up in the processing of sensitized materials but also the replenisher must lower the concentration of the iodides and bromides that have accumulated in the used solution. Satisfactory replenisher formulas depend upon the processing conditions used, the type of solution, and the kind of photographic material being processed. Storage conditions, frequency of use of the developer, the amount and type of agitation, oxidation, how much the sensitized material was exposed, and the degree of development also figure into the compounding of a satisfactory replenisher.

The constituents normally found in the replenisher solution are water, reducing agents (example, metol), sodium sulfite, and an alkali (example, sodium carbonate). The replenisher contains no bromide; in fact, as previously stated, it is normally designed to add a sufficient amount of solution to the existing developer to dilute the accumulated bromides and iodides to a suitable level. Most developer formulas have accompanying replenisher formulas so that you do not have to determine the exact amounts of each of the chemicals that are to be added. However, remember that an emergency replenisher solution can usually be compounded by mixing a modified solution of the developer itself, omitting the bromide. Solutions prepared with such a replenisher solution cannot be expected to maintain the consistency of results that you would get if you used a properly compounded replenisher. There will, however, be a significant extension of the useful life of the developing solution.

NOTE: There are packaged replenishers which are simple and easy to use and therefore do not call for compounding of a formula. In fact, many color processing kits come with replenishers.

Methods of Developer Replenishment. Replenishment is normally done in one of two ways:

a. By intermittently adding given amounts of replenisher as specific amounts of material have been processed in the solution. Normally, the manufacturer indicates how many milliliters of replenisher to add per square foot of processed film. It is therefore necessary to keep a running total of how many sheets or rolls of film have been processed. Through calculation you can determine how many rolls or sheets to the square foot.

This method of replenishment is normally used in hand processing. The correct procedure is to take out an adequate amount of solution from the tank. Then you pour in the correct amount of replenisher. Finally you bring the solution up to level with the old solution that you carried out in step one. This prevents the tanks from overflowing, which will happen if you simply pour in the replenishment solution.

b. By continually adding replenisher at a calculated rate of flow, when processing is being done continuously. This is used in machine processing and is normally done through a pumping system which is controlled by a metering system.

NOTE: In certain cases the developer solution is not replenished, but the processing time is gradually increased as more and more sensitized material is handled.

End Point for Developer Replenishment. The process of replenishment, even with the application of precise analytical procedures, cannot be continued indefinitely. At some point the used solution must be discarded, and processing must be resumed with fresh solution. This is because impurities collect in the used developing solution. These impurities are silver sludge, calcium sulfite sludge, gelatin, degradation products of gelatin, dust, colored oxidation products (which tend to stain the gelatin), etc. It should be standard practice for your laboratory to dump the solution when there is a possibility that the accumulated impurities in the used developing solution may cause image deterioration.

Exercises (681):

1. List four factors that cause the deterioration of a developer.

2. What significant byproducts are formed during development? What effect do they have on developer performance?

3. What testing method is probably best suited for indicating the changes of a developer solution?

4. What normal developer ingredient is excluded from a developer replenisher?

5. On what factor is rate of replenishment normally based?

6. When replenishing a tank, why must you first remove some of the solution?

7. When do you reach the end point of replenishment?

682. State the procedural principles related to replenishing stop baths.

The purpose of a stop bath is to neutralize the activity of the developer, thereby stopping development. Developers are alkaline solutions and must be in an alkaline condition in order for development to take place. The pH of a fresh stop bath is the opposite of developer pH. Stop baths are acid solutions and they neutralize the alkalinity of developers. Stop baths must be in an acid condition to work. Through use, stop baths eventually lose their development stopping capability through the accumulation of developer carryover. If a stop bath is periodically replenished with an appropriate amount of acid, it will continue to work properly.

Detecting Stop Bath Deterioration. The most commonly used stop bath is a solution of acetic acid in water. This is a very satisfactory stop bath when working at moderate temperatures. There are many different stop bath formulations that have additional chemicals besides the acetic acid. When processing at higher temperatures, stop baths that have hardening agents such as chrome alum and sodium sulfate to reduce emulsion swelling can be used.

Physical detection of basic acetic acid stop bath is difficult to determine. One indication is a loss of acidic odor. Freshly prepared acetic acid stop baths have a strong acid odor when fresh and they lose this odor when they become exhausted.

Stop baths that contain chrome alum and sodium sulfate are a violet-blue when freshly prepared and gradually change to a yellowish-green when they become exhausted.

Another type of stop bath that is easy to detect when it is exhausted contains a dye that is invisible at working pH and changes the stop bath to a deep purple color when the stop bath approaches the exhaustion point.

Stop Bath Replenishment. It is usually not feasible to replenish other than basic acetic acid stop baths. Replenish by adding an appropriate amount of acetic acid to maintain the proper solution level and at the same time bring the solution to proper working strength. Stop baths can be replenished intermittently or continuously, depending upon which method is the most feasible or convenient. When a stop bath is included in a machine process, then continuous replenishment is most feasible because the machine does not have to be stopped to replenish. When using continuous replenishment a few tests of the pH of the stop bath per day should be accomplished and the replenishment rate adjusted accordingly.

End point for stop bath replenishment. The end point for replenishment of the acid stop bath occurs when there is a sufficient accumulation of foreign material in the bath to endanger the photographic image. Because of the relatively low cost of the stop bath, it is wise to change the bath any time you must shut down operations to replace the developing solution or the fixing solution. Changing the stop bath does not increase the shutdown time significantly, and it assures you that the stop bath is adequate.

Exercises (682):

1. As a stop bath is used, what takes place to make it ineffective?

2. What visible change takes place as a chrome-alum, sodium-sulfate stop bath deteriorates?

3. What additive is used to replenish an acetic acid stop bath?

4. What is the end point for replenishing an acid stop bath?

5. When would you use continuous stop bath replenishment?

683. List and explain the principles and procedures related to the replenishment of fixing baths.

Replenishment of Fixing Baths. You know that fixing baths tend to wear out. Satisfactory replenishment of fixing baths depends upon a great many things because of the complexity of the solution and the complexity of the changes that it undergoes during use.

Effects resulting from use of fixing baths. We previously covered in general many of the things that take place in fixing baths as they are being used; now we shall be more specific.

Carryover is one of the problems encountered. Carryover of previous solutions into the fixing bath and carryover of the fixing bath into the wash causes changes in the fixing bath activity. Carryover of the previous solutions into the fixing bath tends to dilute the chemical components of the fixing bath; the net effect is to increase the clearing time. But, in addition, if the preceding solution is a water bath, there is a significant dilution of the acidity of the fixing bath. On the other hand, if the preceding solution is a strongly acidic stop bath, the acidity of the fixing bath may be raised. The carryover of alkaline developer tends to neutralize the acid and to convert the bisulfite in the fixing bath to sulfite.

Carryover of the fixing bath into the wash depletes the silver halide solvents of the fixing bath, and this, in turn, increases the clearing time. Also, the fixing bath acidity is reduced because of the carryover of the fixing bath acid into the wash.

Chemical reaction of the fixing bath with the emulsion is a multifold action:

- Complex silver compounds called argentothiosulfates are formed. This reaction tends to use up the thiosulfate.
- Neutral salts are formed. In high concentrations these salts work as retardants. In low concentrations these same neutral salts work as accelerators.
- Iodide is liberated in the fixing bath. Not only does the iodide retard the action of the fixing bath on the silver halides, but it also has the effect of depressing the solubility of the bromide. The net effect is retardation of the clearing action.
- Exhaustion of the fixing bath is accompanied by exhaustion of the sulfite. The loss of sulfite is not too significant, since the other activities usually bring about deterioration of the fixing bath before the sulfite is exhausted.

Deterioration of fixing baths. Deterioration of the fixing bath usually comes about in stages. The first property of the fixing bath to change significantly is its acidity. After the acidity drops below the required level, there is a loss of hardening properties. Then clearing time increases; the clearing time increase is partially due to the exhaustion of the hypo, but primarily due to the concentration of the iodide. Ultimately complex thiosulfates form in the fixer that are insoluble and that cause the image to deteriorate after it has been washed and dried.

NOTE: When a chrome-alum fixing bath exceeds a pH of 6.5, a precipitate of chronium hydroxide forms on the surface of the emulsion.

A good guide to the degree of exhaustion of the common potassium-alum fixing bath is provided by the use of pH indicator papers, since the change in acidity is the first serious change in the fixing bath characteristics.

Methods of Fixing Bath Replenishment. Simply adding fixer replenisher to an exhausted fixing bath will not make it usable. This is because the accumulation of argentothiosulfates in the exhausted fixer will continue to retard fixation. These silver compounds that are a byproduct of fixation, must be broken down to release the silver and allow sodium and thiosulfate to chemically recombine and restore the fixing agent which is sodium thiosulfate. This is done by treatment in an electrolytic silver recovery unit. It is important that you recover silver only from completely exhausted fixer. A partially exhausted fixer, when treated in a silver recovery unit, creates the unwanted combination of silver sulfide, which discolors the fixer and remains in suspension after treatment. The presence of silver sulfide in a fixer will cause prints and negatives treated in it to stain.

Once silver recovery has been accomplished, the fixer may be replenished. Fixer replenisher contains acid to restore the pH of the fixer to normal and hardening agents that have become depleted. Remember to discard an amount of used fixer so that you will have enough room to add the replenisher and bring the solution level back up to normal.

Other Replenishment Additives. Bisulfite in the fixing bath can be regenerated by very cautious additions of dilute sulfuric acid. This is a very critical operation because any excess of acid will cause decomposition of the thiosulfate. This type of replenishment should be done only when you are well aware of the complications involved.

Boric acid is sometimes added to the fixing bath to extend its useful life.

Usually the replenishment of fixing baths (with the exception of minor extensions in their life) is not considered practical unless a silvery recovery process can be used on the solution prior to replenishment.

End point for fixing bath replenishment. Regardless of the replenishment process used, the useful life of fixing bath is ultimately limited by the accumulation of the iodide in the bath. This is true even of fixing baths that have been regenerated through silver recovery and replenished.

Exercises (683):

1. List three chemical reactions that take place in a fixing bath as it is being used.
2. What is the first indicator that a fixing bath is becoming exhausted?
3. Before a fixing bath can be replenished, what procedure must be done?
4. The accumulation of what chemical in the fixer determines the end point of fixing bath replenishment?
5. How is bisulfite regenerated in a fixing bath?

6-5. Storage and Preservation of Sensitized Materials and Photographic Chemistry.

Photographic laboratories always have a generous supply of film, photographic paper, and chemistry on hand to meet daily mission requirements. Up to a six months supply is usually stored in the photo lab. For an average lab, this amounts to quite a lot of materials. To insure that these materials will be usable when they are needed, they must be stored properly.

In this section we discuss the necessity of properly storing sensitized materials and chemistry, where they should be stored, and under what conditions.

684. Specify adverse conditions for storage of sensitized materials and photographic chemistry.

Improper storage techniques and conditions will affect the way photographic materials perform when you try to use them. There are three factors that cause problems in storage. They are: heat, light, and moisture. Let's look at the ways these environmental factors can harm photographic materials.

Heat. Photographic materials must be protected from excessive heat during storage. Prolonged exposure to high temperatures causes film fogging and a change in film speed. Excessive heat causes physical changes to chemistry which affects performance. A combination of heat and air will cause dry chemicals to oxidize and discolor and chemical solutions to evaporate and otherwise break down so that they become unusable. Containers of strong acids or alkalies may burst if stored under high heat conditions.

Light. You already know how light affects sensitized materials. When you take a photograph, you are making a controlled exposure. The problem that we have with light is that it can make an uncontrolled exposure, causing film fogging if the material is not adequately protected. This can happen either before or after you take an exposure, and it makes no difference because your negatives end up ruined either way.

Keep sensitized materials in their light-proof boxes or containers until you need to load film holders or cameras and protect loaded film holders and cameras from intense light while waiting to use them.

Just as with heat, light can affect photographic chemistry. Direct sunlight creates a lot of heat and harmful rays that tend to decompose photographic chemistry. Because of the effects of light, many of the glass containers used to hold chemicals are dark amber to reduce the effects of light on chemicals. This certainly helps, but try to avoid excesses of light and heat by storing bottles of chemicals and chemical solutions in cool, indirectly lit areas.

Moisture. When we talk about moisture, we are most concerned with the effects of too little or too much relative humidity where photographic materials are stored. Low humidity causes film to become brittle, emulsion cracking, and static electricity that fogs film and also attracts dust.

Exercises (684):

1. What change can occur to film stored under excessive heat?

2. What can happen to containers of strong acids or alkalies that are exposed to prolonged periods of excessive heat?

3. How does too little humidity affect photographic materials?

4. What color of glass containers should be used to protect photographic chemicals from the harmful effects of light?

685. List the requirements for and advantages of the different storage methods for sensitized material.

Since sensitized materials are susceptible to heat, light, and moisture, any method that you choose for storage must protect against these three factors. Let's talk about the three storage methods.

Freezing. Since heat is detrimental, a lack of it will slow down deterioration. By keeping sensitized materials frozen, you can practically eliminate any deterioration of the material. The Air Force buys large quantities of photographic sensitized materials and stores them in large freezers at supply depots and individual bases where they are used. A temperature of 0° to -10° F. (-18° to -23° C.) keeps sensitized materials from deteriorating indefinitely.

Refrigeration. This is the type of medium term storage that most photo labs use. It is temporary storage because materials should not be stored under refrigeration longer than six months without possible deterioration. A refrigeration unit used to store sensitized materials must be capable of maintaining a temperature of 50° F. (10° C.) or lower.

Storage at Room Temperature. This is the least desirable method of storing film and paper and should never be used to store large quantities of materials. However, you will need to use it to store enough materials for daily mission requirements. When storing sensitized materials at room temperatures, avoid temperatures above 75° F (24° C.).

Humidity For Storage. Regardless of the method you choose to store sensitized materials, the storage area must maintain a relatively humidity that causes no harm to the materials that you are storing. The ideal relative humidity for storage and also the laboratory environment is 50 percent. Refrigerators or freezers used for storage should be capable of maintaining humidity between 40 and 50 percent.

Your method of storage depends upon what you have available to use and how long you must store the material. Most photo labs do not have freezer facilities. This is unimportant since you should have a maximum of only six months worth of supplies on hand. For short term storage, store at room temperature, only enough materials that will allow you to do your job for the next few days.

After taking sensitized materials out of cold storage, they must be warmed up to room temperature before they can be unwrapped and used. It may take up to eight hours to bring items up to room temperature, depending on whether they are frozen or refrigerated. Never unpackage sensitized materials until they are up to room temperature. Most materials are protected by a moisture-proof inner wrapper. If you open the wrapper while the material is still cold, condensation will form on the material and possibly do damage. By leaving the material wrapped up, any condensation that forms will form on the packaging material and not on the sensitized material itself.

Exercises (685):

1. What are three methods that can be used to store film?

2. What method of sensitized material storage is least desirable?

3. How can you avoid condensation on sensitized materials after removing them from cold storage?

4. At what maximum temperature should a refrigerator used to store sensitized materials be set?

5. What is the ideal relative humidity for a sensitized material storage area?

6. How long can sensitized materials be safely stored under refrigeration?

7. What type of cold storage is most often found in base photo labs?

686. Specify proper storage conditions for photographic chemistry.

Photographic chemicals and chemical solutions must be provided a storage area within the photo lab that is physically apart from where sensitized materials are stored. This greatly reduces the possibility of deterioration of sensitized materials from exposure to chemical vapors and dust.

The environment for storing chemicals should be a cool, dry room because most chemicals deteriorate from exposure to air, moisture, or excessive heat.

Some chemicals such as mercuric chloride are very hazardous and should be stored in a locked cabinet to prevent their being handled by inexperienced or unknowledgeable personnel. When deciding where to store hazardous chemicals, make sure that you don't store chemicals together that are hazardous when combined. There is always a danger of breakage during storage, and such chemicals as sulfuric acid and potassium ferrocyanide, when combined, produce lethal cyanide gas. Provide separate locked cabinets for these items. Such chemicals should also be stored on the lower shelves in these cabinets to further reduce the chances of accidental breakage. As a general rule, store heavy items such as large bags of fixer, glass containers, and hazardous chemicals on lower shelves and lighter, unbreakable, or less hazardous chemicals on the higher shelves.

The storing of processing solutions presents numerous problems, most of which are directly attributable to the chemicals they contain. For example, most stock developer solutions have good keeping qualities when stored in full, tightly stoppered bottles. When storing solutions in bottles, it is important that you always fill the bottle completely, displacing all the air in the bottle to prevent oxidation. Developers stored in tanks should be covered by a floating lid.

Fixing baths have good keeping properties and can be stored in tanks as long as you use dust covers over the tanks to prevent contamination. Always store corrosive solutions such as acids, bleaches, and stop baths in acid-resistant containers. Glass or crockery containers with rubber or glass stoppers are suitable for this purpose.

Finally, always make sure that every container used to store chemicals and chemical solutions is properly labeled with the contents of the container. Hazardous chemicals should be identified with approved warning symbols.

Exercise (686):

1. Complete the following statements about storage of photographic chemistry:
   a. Chemicals deterioriate when exposed to _____ , _____ , and _____ .
   b. A combination of sulfuric acid and potassium ferrocyanide produces lethal _____ gas.
   c. Heavy or hazardous items should be stored on _____ shelves.
   d. Acids and bleaches should be stored in _____ containers.
   e. Air causes chemical solutions to _____ .

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ANSWERS FOR EXERCISES

CHAPTER 1

Reference

600 - 1. a. The developer produces a silver image by reducing exposed silver halides to black metallic silver.
b. The stop bath stops the action of the developer.
c. The fixer makes the image permanent by dissolving the unexposed and undeveloped silver halides.
d. The hypo clearing bath raises the pH of the fixer within the emulsion which causes the byproducts to wash out faster.

601 - 1. Formula and proprietary.
601 - 2. Packaged chemicals are easy to store, handle, and mix; and they provide consistent quality.
601 - 3. Follow directions.
601 - 4. In a well-lighted and ventilated room.

602 - 1. Bulk chemicals permit you to prepare solutions you rarely use or those which are not available in packaged form. You will therefore be able to meet special mission requirements you would otherwise be unable to meet.
602 - 2. USANSI Photo Grade.
602 - 3. Technical grade chemicals can be used after they have been thoroughly tested and found to be satisfactory.
602 - 4. Bulk chemicals should be stored in dark stoppered bottles or jars that are shelved in a cool, dry place away from sensitized materials. All containers should be properly labled.
602 - 5. To take advantage of bulk chemicals, you need a properly stocked chemical mix section. An accurate balance, graduates, thermometer, and stirring rods are a few of the basic items that are required.
602 - 6. Acid should always be slowly added to the water. If water is added to an acid, tremendous heat can be generated, boiling and splattering may result, and you may suffer serious burns.

603 - 1. 50.
603 - 2. Valve B.
603 - 3. Air.
603 - 4. Open.
603 - 5. Recirculating.

604 - 1. Following directions is necessary to insure proper quality and safety.
604 - 2. Water; temperature.
604 - 3. Ingredient; water.
604 - 4. Quick reference; backup source of information.

605 - 1. Mix 25 grams of hydroquinone into 100 cc of water.
605 - 2. Mix one part D-72 with 3 parts of water. All parts must be measured with the same weighing system (e.g., ounces).
605 - 3. 20° C.
605 - 4. 122° F.
605 - 5. 20 percent.

606 - 1. Metric or avoirdupois.
606 - 2. The smaller the quantity to be weighted, the greater must be the accuracy of the balance.
606 - 3. a. Sliding; individual.
b. Paper.
c. Trimming.
d. Left-handed.
e. Right-handed.
f. Sheet or disc of paper.
g. Tweezers or forceps.
606 - 4. That the material is inert to the chemicals that will be measured.
606 - 5. 2.5.

607 - 1. a; c.

608 - 1. An ammonium thiosulfate fixing bath is exhausted primarily by dilution. Silver recovery, therefore, does not extend its life. A sodium thiosulfate fixer is sensitive to silver buildup; therefore, silver recovery does extend its life.
608 - 2. Electrolytic silver recovery allows reuse of fixer.
608 - 3. Low volume photo labs that generate less than 30 gallons of used fixer per 8-hour day.
608 - 4. Chemical precipitation requires special facilities and manpower requirements. It also generates noxious fumes.

609 - 1. Incineration; emulsion stripping.

610 - 1. a. Heavy.
b. Locked.
c. Left in place.
d. Heating.
e. Hands; dry.
f. Water; mix; transfer.
g. Oxidation; contamination.

CHAPTER 2

611 - 1. An acceptable negative is one that retains the tone values and contrast of the scene.
611 - 2. Grain size is most noticeable when enlargements are made from small negatives.
611 - 3. As you enlarge the image of a small negative you also enlarge the grain.
611 - 4. a; b; d.

612 - 1. In tanks using hangers.
612 - 2. Spiral reels and tanks.

613 - 1. To transmit the maximum amount of light that can be used safely without damage to the sensitized materials being handled.
613 - 2. a. (3).
b. (1).

c. (2).
d. (4).
613 - 3. If you use too bright a bulb, it may damage the safe-light filter and may fog the materials.

614 - 1. Tank and hanger processing gives more even processing and makes the solutions last longer.
614 - 2. A film hanger is a channeled frame suspended below a bar. The film fits in the channels.
614 - 3. All hangers should be lowered into the solution simultaneously. This ensures uniform agitation and even development.
614 - 4. Agitation involves these steps: lower the hanger into the solution; raise them straight out; turn them approximately 90°; lower them into the solution.

615 - 1. Too little tension will not allow the film to get into the spiral reel. Too much tension will cause the film to jam and buckle, overlapping in the grooves.
615 - 2. This will allow more even development.
615 - 3. Put a film clip at the end of the roll.

616 - 1. Time; temperature.
616 - 2. Useless.
616 - 3. 20 (68° F.).
616 - 4. Softening.
616 - 5. Inspection.
616 - 6. Reticulation.

617 - 1. The purpose of agitation is to cause a more rapid exchange of the used solution absorbed into the gelatin and the fresh solution from outside the gelatin.
617 - 2. An underdeveloped negative a negative that lacks a good tonal scale, detail, and contrast.
617 - 3. By stacking them, emulsion side up, in the tray and rotating them from the bottom to the top.
617 - 4. The basic difference is that tray agitation requires continuous agitation whereas tank agitation is intermittent.

618 - 1. A black-and-white positive can be made by contacting the original negative with copy film and then processing the film in the normal manner, following the directions for the specific type of film.
618 - 2. To prevent buckling of the film when the film is subjected to the heat of the projector.

619 - 1. Stain.
619 - 2. Tray.
619 - 3. Amount; How rapidly.
619 - 4. Three.
619 - 5. Twenty.

620 - 1. Wetting agents cause water to run off of the film evenly. This promotes even drying and reduces the chances of water spots forming.
620 - 2. Bathe the film in the wetting agent for 2 minutes. Drain the film, sponge it off, and hang the film to dry.

621 - 1. Attach metal clips at the free end.
621 - 2. Set the heat thermostat at its lowest setting.
621 - 3. Dust can sometimes be brushed off. You may have to rewash the film and allow it to dry again.
621 - 4. Film drying rate is controlled by the amount of heat, humidity, and air circulation.
621 - 5. Excessive heat will curl the film.
621 - 6. Water spots are serious because they cannot be removed.

622 - 1. The purpose of opaquing is to eliminate clear spots or areas in the negative.
622 - 2. a. White.
b. Base.
c. Water soluble opaque.
d. Sodium sulfite.

623 - 1. You should have listed any five of the following:
(1) Focus
(2) Exposure
(3) Defects
(4) Contrast
(5) Grain
(6) Identity
(7) Pleasing
623 - 2. The ultimate factor to consider is the final print must be pleasing.

624 - 1. AFR 95-4.
624 - 2. Letter on the widest clear margin.
624 - 3. 307c.
624 - 4. It can be washed off if you make a mistake.
624 - 5. Cotton gloves help prevent fingerprints.

625 - 1. Moisture, light, and heat.
625 - 2. From 25 to 50 percent.
625 - 3. High humidity promotes fungus growth.
625 - 4. A duplicate negative should be made if a particular negative will receive excessive handling.

626 - 1. Floating lids prevent oxidation.
626 - 2. Rinse processing reels with running water.
626 - 3. Use water and a nonabrasive pad or sponge to clean stainless steel. Do not use abrasives.
626 - 4. The air filter is beneath the floor panel of the drying cabinet.

CHAPTER 3

627 - 1. A definite routine results in less waste, is not as tiring, and is also safer.
627 - 2. A temperature of 70° F. (21° C.) provides a comfortable working environment and is an aid in maintaining proper solution temperatures.
627 - 3. The two types are a clock and an interval timer. The clock is used to time the processing steps. The interval timer is used to control print exposure.
627 - 4. You need two sets in order to prevent contamination. One is used in the developer and to transfer the print to the stop bath. The second set can handle the print through the remaining steps.
627 - 5. Cleanliness saves time and materials. A common cause of poor-quality darkroom production is a lack of cleanliness.

628 - 1. b., e., g.
628 - 2. That the mixing container is cleaned and that it is made of material that will not react with the chemicals to be mixed.
628 - 3. Follow the manufacturer's directions.
628 - 4. It is a good idea to wear rubber gloves and a face mask.
628 - 5. Splashing of the solution and the introduction of air into the solution.

629 - 1. Constant agitation, because they are in a tray.
629 - 2. Place the print into the developer emulsion up or down. However, make sure you get the print wet evenly and quickly.
629 - 3. You need to have your timer start as the sheet is going into the solution. You also need to provide for a 10-second drain time at the end. Thus, if you have a 2-minute processing time, you should continuously agitate for 1 minute and 50 seconds and then drain the print for 10 seconds before putting the print into the stop bath.
629 - 4. Agitate the sheets of paper by rotating them from bottom to top through the stack. As you bring the bottom print up, put it emulsion side down on the top of the stack. The next time you go through the stack, put the prints emulsion side up. Continue this procedure through the development time.

630 - 1 It stops the development without allowing development to continue beyond the proper time.

630 - 2 The main advantage is that an acid stop bath reacts chemically with the developer solution remaining on the print. This chemical reaction stops the action of the developer. A water stop bath only dilutes the action of the developer; it does not stop it.

630 - 3 Normally, from 15 to 30 seconds.

630 - 4 To prevent excessive swelling or softening of the emulsion. (This is particularly important when you are processing at high temperatures.)

630 - 5 The advantage of resin-coated paper is that it can be fixed in 2 minutes, a period of time considerably shorter than that necessary for other types of paper.

631 - 1. As the solution temperature rises, the processing time is reduced to achieve the same degree of development. Conversely, as the temperature decreases, the processing time increases to achieve the same degree of development.

631 - 2. Use a thermometer to check the temperatures and a water mixing valve to get the water for mixing the solutions to the right temperature.

632 - 1. A number of oxidation and chemical byproducts are formed as the developer changes the exposed halides to black metallic silver.

632 - 2. Mottle is streaky development. It is caused by a lack of agitation during development of the print. The defect occurs because the diffusion of fresh developer and reaction byproducts from within the emulsion takes the path of convection currents. These currents form random patterns that cause uneven development.

632 - 3 Air bells are tiny bubbles in the developing solution. They can cling to the paper emulsion, causing clear spots to occur on the prints because there was not full development.

632 - 4. Tray; prints.

633 - 1 b; c; e

634 - 1 1 Soft; 3 Moderately high contrast; 5 Very high contrast

634 - 2 Number 2

634 - 3 By matching the contrast of the negative to the proper grade of paper

635 - 1 Blue-violet and yellow-green

635 - 2. Colored filters.

636 - 1.
a Number 2 (or no filter)
b Number 4
c Number 1

636 - 2 From number 1 (light yellow) to number 4 (dark magenta), with intervals of 1 2.

636 - 3 Because variable-contrast paper is sensitive to green, using this yellow-green filter would cause fogging.

637 - 1 The finish and texture of the paper.

637 - 2 The paper's surface controls the amount of light that is reflected from the print, thereby transmitting or obscuring detail. It is, therefore, important to match the surface to the type of image you wish to convey.

638 - 1. c
638 - 2. a.
638 - 3 b
638 - 4 a
638 - 5 c
638 - 6 b
638 - 7 a

639 - 1 Tone is the overall color of the image produced by the paper. Some papers produce a warm tone, while others are much colder.

639 - 2. Print contrast is the difference between the highlights and the shadows of the print image. The greater the difference, the higher the contrast.

639 - 3. The final appearance of the print will depend as much on the type of paper that is selected, the choice of developer, your exposure and contrast control techniques as on the quality of the original image.

639 - 4. The inherent contrast of the negative, the choice of graded paper or variable-contrast filter, and your developer.

639 - 5. Mission requirements are the reason why you are producing the print. The requirements of the mission will influence the choice of paper and your printing techniques. If your product does not meet mission requirements, you have not been successful.

640 - 1.
a. 4.
b. 1.
c. 4.
d. 3.
e. 1.

640 - 2. Roll-type filters.

640 - 3. The filters should be clean and in good order. If a filter fades with age, it must be replaced.

640 - 4. Argon lighting is very rich in blue and, therefore, doesn't have the green spectral quality necessary for variable-contrast paper.

641 - 1. Platen.
641 - 2. Individual lamps.
641 - 3. 9.5.
641 - 4 Filter
641 - 5. Diffusion.

642 - 1. The negative and the paper should be placed emulsion to emulsion, with the negative laid emulsion side up on the contact printer glass.

642 - 2. Examine the paper carefully: the paper will have a slight curl toward the emulsion, and the emulsion side will reflect more light.

642 - 3. The sizes of the images should be the same.

642 - 4. By contact printing strips of roll film negatives or a couple of cut film negatives on an 8 x 10 sheet of paper.

643 - 1. Lens-to-negative.
643 - 2. Diameters.
643 - 3. Dustless; glass-sandwich.
643 - 4. Diagonal.
643 - 5. Smaller.
643 - 6. Condenser.
643 - 7. Diffusion.

644 - 1 100.
644 - 2. 4x5.
644 - 3. Emulsion.
644 - 4. Locking; projector head.
644 - 5. Raise.

645 - 1. Dust and lint will cause the projection light to be diffused, causing white spots to appear on the print. Dust and lint can be brushed, wiped, or blown off. In more difficult cases, the negative may need to be cleaned with alcohol or negative cleaner.

645 - 2. The negative and the paper should face emulsion to emulsion.

645 - 3. The image size is controlled by the distance from the lens to the paper. This can be changed by raising or lowering the printer head. As the distance increases, the image size increases.

645 - 4. Horizontal and vertical.

645 - 5. In projection printing, you have control over the image size, and you can easily change the format. This flexibility is not available in contact printing.

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646 - 1. Negative, paper.
646 - 2. Opaque leader material.
646 - 3. The type with a fixed frame, and the type with adjustable masking strips.

647 - 1. Cut the frisket to the proper size. Hold the frisket so you can read it and then place tape on the back side of it. Place the frisket onto the easel frame. Check to see if it is straight and flat and that no tape is showing in the image area.

648 - 1. Test strips are used to calculate printing exposure and to determine the correct paper grade or variable-contrast filter to use.
648 - 2. Test strips are economical because several can be cut from one sheet of print paper. This procedure is far cheaper than making tests on full sheets of paper.
648 - 3. Inspect the highlight areas of the test strip carefully. The highlights should be slightly darker than unexposed paper and have some detail.
648 - 4. Carefully examine the shadow area of the test strip that has the correct highlight exposure. If the shadow area of this test is too light, the paper does not have sufficient contrast. If the shadow area is too dark, the paper has too much contrast.

649 - 1. The purpose of dodging is to reduce density in a particular area of a print.
649 - 2. By turning off individual printing lights.
649 - 3. To add density in a local area of a print.
649 - 4. To burn-in during projection printing, you first make your basic overall exposure. You then make your additional exposure, using a piece of cardboard with a hole in it. The hole will pass the light to the area that needs additional exposure while holding back light in those areas that don't need any more.
649 - 5. If you do not move your dodging or burning-in tool during exposure, an outline of the tool will be "printed" on the paper.
649 - 6. Flashing is the deliberate fogging of a print to darken specific parts of the print and to obscure detail.
649 - 7. Remove the negative from the carrier, leaving the carrier in the enlarger. Hold a piece of cardboard (dull both sides) about 3 to 4 inches under lens. Turn the enlarger on while moving the cardboard back and forth rapidly during the exposure.

650 - 1. The horizon line should be level and should not divide the picture in half.
650 - 2. Live subjects should be looking into the picture, not out of it.
650 - 3. As cropping guides, which you can use to determine the best picture crop.
650 - 4. When you are projection printing and need to have a bigger image size.
650 - 5. The subject. (Tall, thin subjects are best shown vertically, while broad subjects appear better horizontally.)

651 - 1. Small.
651 - 2. Upward.
651 - 3. Small.
651 - 4. Large.
651 - 5. Two.

652 - 1. First you contact the original with a sheet of copy film to produce a positive. With the positive, you can then produce as many duplicate negatives as you need.
652 - 2. In projection printing, you can produce a master that is cropped, dodged, and burned in.
652 - 3. The limited selection of film sizes and more involved processing.
652 - 4. High contrast.

653 - 1. End.
653 - 2. Front.
653 - 3. Eight.
653 - 4. Moisture; light; heat; chemical fumes; careless handling.
653 - 5. 70° F. (21° C).

654 - 1. You should have included three of the following:
(1) Cleanliness.
(2) Operation of bulbs.
(3) Operation of switches.
(4) Proper grounding.
(5) Cracked, leaky platen.
654 - 2. Check negative carriers for square corners, scratches, and burrs. Glass carriers need to be checked for broken and scratched.
654 - 3. Keep timers clean and position them where water and chemicals cannot be splashed onto them.

CHAPTER 4

655 - 1. The seven factors are (1) the proper fixing of the print, (2) temperature of the water, (3) type and weight of the paper, (4) method of washing, (5) rate of water exchange, (6) amount of agitation, and (7) use of a hypo clearing agent.
655 - 2. It will become discolored.
655 - 3. Every 5 minutes.
655 - 4. The higher the water temperature, the faster the chemicals are diffused. Therefore, if you wash the prints in 75° F water, your washing time will be less than if you used colder water.
655 - 5. Double-weight paper is thicker and absorbs more chemicals. Therefore, it takes longer to wash double-weight paper.

656 - 1. True.
656 - 2. False.
656 - 3. False.
656 - 4. True.
656 - 5. False.

657 - 1. Paper base.
657 - 2. Glycerin; 10.
657 - 3. Stretching; shrinking.
657 - 4. Ferrotype tin (plate).
657 - 5. Curl.
657 - 6. Softening bath.
657 - 7. Crack.
657 - 8. Mosaics (maps).
657 - 9. Plumming.

658 - 1. Down.
658 - 2. Up.
658 - 3. Faster.
658 - 4. Desired temperature setting.
658 - 5. Water.
658 - 6. Binding.
658 - 7. Heater.
658 - 8. Temperature, humidity.
658 - 9. 24.
658 - 10. Safety thermostat, heaters.
658 - 11. Opening, closing.
658 - 12. Dry; flat.

659 - 1. The cardstock's color, size, texture, and weight should enhance the print image to be mounted.
659 - 2. The five steps are: (1) place the print on the upper left corner of the mount; (2) divide the distance on the right-hand side and draw a fine vertical line down the mount; (3) divide the distance from the bottom of the print to the bottom of the mount in half and draw a fine horizontal line across the mount; (4) draw a fine diagonal line from the bottom left edge of the print to the point where the horizontal line drawn in step 3 ends on the right-hand side of the board; and (5) mount the print with the right side along the vertical line drawn in step 2 and with the lower right corner touching the point formed by the intersection of the line drawn in step 2 and the diagonal line drawn in step 4.
659 - 3. Wet mounting may not produce a permanent mount and may also cause stains and smears.

659 – 4. It is a clean, simple, efficient process that results in a bond that is normally permanent.

660 – 1. That the set temperature has been reached.
660 – 2. 235° F. (114° C.).
660 – 3. Place the untrimmed print face down on a table and put a piece of dry mounting tissue, slightly larger than the print, on top of it. Tack the dry mounting tissue to the print by drawing the beveled edge of the tacking iron across the tissue at several points. With the mounting tissue secure, turn the print face up and trim it to its final size. Then tack the print to the mounting board, and you are ready for the press.
660 – 4. The right amount of heat insures good results. Too little heat and there will not be adequate fusion. Too much heat and the adhesive will be absorbed. In either case, you will not have a permanent bond.

661 – 1. AFR 95–4.
661 – 2. Ink stamping.
661 – 3. RC paper will not absorb the ink. Therefore, you must use ink that will dry quickly enough to prevent running and smearing.

662 – 1. Daily.
662 – 2. Lines indicate the drum is scratched.
662 – 3. Pock marks.
662 – 4. Open the sliding cover.
662 – 5. Use a cover sheet while mounting prints.

663 – 1.
  a. Light.
  b. White; ultraviolet; infrared.
  c. 400; 700.
  d. Adaptability.
  e. Magenta.
  f. Absorption; reflection.
  g. Metals.
  h. Light-wave interference.
  i. Dispersion.
  j. Fluorescent.
  k. Saturation.
  l. Primary.

664 – 1.
  a. Three.
  b. Yellow.
  c. Magenta; yellow; cyan.
  d. Blue.

665 – 1.
  a. One, two.
  b. Blue.
  c. Green; blue.
  d. No.
  e. Magenta; yellow.

666 – 1
  a. Three.
  b. Green.
  c. Yellow; top; middle.
  d. Panchromatic; red.
  e. Top; middle.
  f. Red.
  g. Blue.
  h. Red.
  i. Red.
  j. 3400.

667 – 1. The relative humidity should be maintained between 40 and 50 percent.
667 – 2. The temperature should be between 0° F. and –10° F.
667 – 3. Improper storage will result in loss of film speed and color balance.
667 – 4. No. Film stored near chemicals is likely to be damaged by chemical vapors.

668 – 1. The exposure latitude of reversal film is 1/2 under to 1/2 over.
668 – 2. The contrast ratio should be maintained at 3:1.
668 – 3. One way to reduce a scene's contrast is to use supplementary lighting.
668 – 4. Underexposure will result in heavy dye densities.

669 – 1.
  a. 80A.
  b. 81A.
  c. FLD.
  d. CC30R.
  e. 81A.
  f. 80C.
  g. 82A.

670 – 1. b; c; f; g; h; i; j; l.

671 – 1. Two stops overexposure.
671 – 2. Underneath.
671 – 3. 4 times (400%).
671 – 4. The filtration is determined by trial and error.

672 – 1. The first developer produces a black metallic silver image.
672 – 2. You must place the film in the conditioner before it is bleached. The conditioner makes the metallic silver ready to be bleached.
672 – 3. Color developer.
672 – 4. The stabilizer improves dye stability and contains a wetting agent which promotes even drying.
672 – 5. The reversal bath chemically exposes the silver halides that were not exposed in the camera.
672 – 6. The fixer converts the silver halides into soluble silver complexes, most of which are retained in the fix.

673 – 1. Liquid concentrate.
673 – 2. 1 gallon (3.79L).
673 – 3. Contamination.
673 – 4. One week.
673 – 5. Oxidation.

674 – 1. First developer.
674 – 2. After the reversal bath.
674 – 3. Small daylight tanks.
674 – 4. Manual.
674 – 5. Gaseous burst.
674 – 6. Rap the hangers or reels against the tank.
674 – 7. Bleach.
674 – 8. Manual or gaseous burst.

675 – 1. 68° to 140° F. (20° to 60° C.).
675 – 2. Use a soft sponge to make one pass on each side of the film.
675 – 3. Excessive drying temperature will cause the film to curl.

676 – 1. Glass mounts are durable, offer good protection, and can be made waterproof by using waterproof tape.
676 – 2. Glass mounts are time consuming to use, costly, some are too thick for projectors, and Newton rings can be a problem.
676 – 3. Glassless mounts are cheap, adaptable, have no glass breakage, no Newton rings, and are easier to use. The disadvantage is loss of projection.

677 – 1. False.
677 – 2. True.
677 – 3. False.
677 – 4. False.
677 – 5. False.
677 – 6. False.

CHAPTER 6

678 – 1. If you clean camera equipment in the loading room, dust may be stirred up and then settle back onto the film and equipment. The loading room needs to be kept as dust-free as possible, so you should not clean your equipment there.
678 – 2. The dry side of a lab is always dry. Wet solutions should never be placed on the dry side.
678 – 3. Down-loaded film should be given the same protection as unexposed film. Store it in a clean, light-tight box.

678 – 4. Wet chemicals splashed on the floor will dry and become powdery. They may be tracked about the lab and cause contamination.
678 – 5. Use as little solvent as is necessary.

679 – 1.
  a. Overexposure.
  b. Overexposure.
  c. Hazy negatives can be caused by: sun shining into the lens; a dirty lens, overexposure, or fogging.
  d. Reticulation.
  e. Hypo in the developer or a brief exposure to light during development.
  f. Air bubbles on the film during fixing.
  g. Chemical or light fog.
  h. Lack of agitation in an acid stop bath.

680 – 1. A specific gravity test is performed to indicate if a solution was properly mixed.
680 – 2. (1) c; (2) a; (4) b.

680a – 1. pH indicators; pH meters.
680a – 2. A buffer is a solution having a known pH value and is used for calibrating pH meters.

680b – 1. Exposure; processing.
680b – 2. Standardization.
680b – 3. Sensitometry provides a standardized set of exposures that, when processed, will provide a quality control check of the process.
680b – 4. c.

680c – 1. Densitometer.
680c – 2. c, f.

680d – 1. No.
680d – 2. Upper control limit; lower control limit.
680d – 3. Corrective action.

681 – 1. The four factors are chemical reaction of the developing solution with the silver halides of the emulsion; action of the air upon the solution; loss of solution through carryover to the following tank; and dilution of the developer.
681 – 2. The most significant byproducts are bromides and iodides. They both have a restraining effect on development.
681 – 3. Sensitometric testing, because such testing shows you the results that are being produced by your developer.
681 – 4. Bromide is not included in a developer replenisher.
681 – 5. Rate of replenishment is normally related to the amount of film (material) being processed.
681 – 6. By removing some of the solution you will better ensure that you will not overflow the tank. You can then pour back a sufficient amount of the old solution to top off the tank.
681 – 7. End point of replenishment is reached when the solution is so contaminated with impurities that it may cause image deterioration.

682 – 1. Developer carryover into the stop bath causes gradual deterioration.
682 – 2. They change from violet-blue to yellowish-green.
682 – 3. Acetic acid.
682 – 4. A stop bath has reached its end point when enough foreign material is present to endanger the material.
682 – 5. Continuous stop bath replenishment is used in machine processors.

683 – 1. You should have listed any three of the following: (1) complex silver compounds called argentothiosulfates are formed; (2) neutral salts are formed; (3) iodide is liberated; (4) there is a loss of sulfite.
683 – 2. The acidity drops below the required level.
683 – 3. You must recover the silver.
683 – 4. Iodide.
683 – 5. By very cautious additions of dilute sulfuric acid.

684 – 1. High temperatures can cause film fogging and a change in film speed.
684 – 2. They may burst.
684 – 3. Low humidity causes film to become brittle, emulsion to crack, and static electricity which may fog the film.
684 – 4. Amber.

685 – 1. Freezing, refrigeration, room temperature.
685 – 2. Room temperature.
685 – 3. Allow material to come up to room temperature before opening the containers.
685 – 4. 50° F. (10° C.).
685 – 5. Between 40 percent and 50 percent.
685 – 6. Six months.
685 – 7. Refrigeration.

686 – 1.
  a. Air, Moisture, Heat.
  b. Cyanide.
  c. Low.
  d. Glass.
  e. Oxidation.

379

S T O P - 1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.
2. USE NUMBER 2 PENCIL ONLY.

EXTENSION COURSE INSTITUTE
VOLUME REVIEW EXERCISE
[illegible] 04 22
PHOTOGRAPHIC LABORATORY APPLICATIONS

Carefully read the following:

DO's:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that item numbers on answer sheet are sequential in each column.
3. Use a medium sharp #2 black lead pencil for marking answer sheet.
4. Write the correct answer in the margin at the left of the item. (When you review for the course examination, you can cover your answers with a strip of paper and then check your review answers against your original choices.) After you are sure of your answers, transfer them to the answer sheet. If you have to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If mandatorily enrolled student, process questions or comments through your unit trainer or OJT supervisor. If voluntarily enrolled student, send questions or comments to ECI on ECI Form 17.

DON'Ts:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. [illegible] the answer sheet.
4. [illegible] lead pencil.

NOTE: LEARNING OBJECTIVE NUMBERS ARE USED ON THE VOLUME REVIEW EXERCISE. In parenthesis after each item number on the VRE is the Learning Objective Number where the answer to that item can be located. When answering the items on the VRE, refer to the Learning Objectives indicated by these Numbers. The VRE results will be sent to you on a postcard which will list the actual VRE items you missed. Go to the VRE booklet and locate the Learning Objective Numbers for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

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MULTIPLE CHOICE

1. (600) The function of a developer is to produce a

   a. negative.　　c. metallic halide.
   b. positive.　　d. silver image.

2. (600) The alkalinity of the developer is counteracted in a stop bath which contains

   a. water.　　c. acid.
   b. hypo.　　d. alum.

3. (600) Which one of the following solutions makes the image permanent?

   a. Fixing bath.　　c. Stop bath.
   b. Developer.　　d. Indicator.

4. (601) What are the two basic types of prepackaged chemistry?

   a. Liquid and concentrated.　　c. Cubitainer and powder.
   b. Formula and proprietary.　　d. Exclusive and public.

5. (602) To which of the following do the terms, primary standard, reagent grade, purified, and U.S.P. relate?

   a. Types of photographic developers.
   b. Purity of chemical solutions.
   c. Concentration of acids in solutions.
   d. Quality of bulk chemistry.

(603)
6. The A-1 Mixer/Distributer is designed

   a. for missing and transferring chemicals.
   b. for limited use field labs.
   c. to recirculate caustic solutions.
   d. to operate on batteries or 110V A.C.

8. (604) Select the publication which contains the mixing instructions for the most chemicals.

   a. CDC 23132.
   b. Encyclopedia of Photography.
   c. Air Force Manual 52-1.
   d. Photo Lab Index.

9. (605) A 1:4 solution of D-72 would require

   a. 1 ounce of D-72 and 4 quarts of water.
   b. 1 quart of D-72 and 4 gallons of water.
   c. 2 quarts of D-72 and 5 quarts of water.
   d. 2 ounces of D-72 and 8 ounces of water.

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10. (606) Which of the following is an advantage of using glass graduates?

a. They will not stain.
b. Glass is inert to most chemicals.
c. Calibration marks are easier to see.
d. Glass graduates are marked in ounces and liters.

11. (607) Which of the following practices is not consistent with Air Force environmental practices?

a. Dumping photo chemicals in large bodies of water.
b. Installation of treatment facilities.
c. Insure contracts for disposal of wastes meet local standards.
d. Store and handle products in a manner that will minimize pollution.

12. (608) Which silver recovery method generates noxious fumes?

a. Chemical precipitation.
b. Metallic replacement.
c. Incineration.
d. Electrolytic.

13. (609) What are the two methods of recovering silver from black-and-white film?

a. Precipitation and replacement.
b. Shredding and electrolytic.
c. Regeneration and smelting.
d. Incineration and stripping.

14. (609) Select the correct statement regarding the recovery of silver from film.

a. The stripping method is more expensive than incineration.
b. Regeneration and smelting require extremely high temperatures.
c. Shredding is preferred for large volume labs.
d. Precipitation recovery units may be used in small labs.

15. (610) Small individual weights should be handled with tongs or gloved hands to

a. ensure accurate measurements.
b. prevent dropping and scratching.
c. ensure proper placement in the pan.
d. prevent fingerprint corrosion.

16. (611) Which of the following situations would require the use of a fine grain negative developer?

a. Shooting high speed action photography.
b. Copying highly reflective subjects.
c. Producing enlargements from small negative.
d. Making black-and-white prints from color negatives.

17. (611) Film and developer combinations should be based on

a. the time requirements of the mission.
b. the size of the prints to be made.
c. grain size characteristics of the paper.
d. whether you use roll film or sheet film.

18. (612) Why is tank processing preferred for sheet film?

a. There is less chance of temperature variations.
b. It can be done with the room lights on.
c. You can use a stronger light in the safelight.
d. Results are more uniform for large numbers of sheets.

19. (613) What color of safelight filter would best be suited for use with panchromatic film?

a. Light red.
b. Dark blue.
c. Light yellow.
d. Dark green.

20. (614) Which of the following is the proper method of placing loaded film hangers into the developer?

a. Place each hanger in separately.
b. Lower all of the hangers simultaneously.
c. Stack the hangers from the bottom up.
d. Alternate the hangers at 90° angles.

21. (614) Which processing solution does not require agitation?

a. Developer.
b. Stop bath.
c. Fixer.
d. Wetting agent.

22. (615) Which of the following statements is true regarding the processing of roll film?

a. The film is attached to the reel with the emulsion facing inward.
b. Roll film processing is best accomplished by using trays.
c. Sprocket holes must be trimmed off prior to processing.
d. The film is soaked in wetting agent to remove the paper backing.

23. (616) Temperatures of the processing solutions should be

a. maintained below 68° for all films.
b. checked after you place the film in the developer.
c. lowered if you have to process a large volume of film.
d. held as near to each other as possible.

24. (616) When the emulsion is subjected to excessive expansion and contraction it is said to be

a. accelerated.
b. reticulated.
c. intensified.
d. emulsified.

25. (617) What will happen to a negative if the film is not adequately agitated in the developer?

a. The shadows will be too dark.
b. The middle tones will block up.
c. The highlights will be underdeveloped.
d. The contrast will be excessive.

26. (617) Film is agitated in a roll film tank by

a. vigorous rocking of the tank.
b. releasing gas into the tank.
c. turning the agitation rod.
d. inverting the tank.

27. (618) Which type of film is best suited for making black-and-white positives?

a. Fine grain positive.
b. Course Grain positive.
c. Single-step positive.
d. Commercial contrast positive.

28. (619) Select the equipment which is designed to improve the efficiency of tray washing?

a. Ingester.
b. Siphon.
c. Extractor.
d. Ladle.

29. (619) Which of the following is most likely to cause your negatives to be stained?

a. Omitting the clearing bath.
b. Using wash water that is too hot.
c. Leaving film in film hangers to dry.
d. Allowing byproducts to remain in the film.

30. (620) A solution should be used to break the surface tension of water on the film in order to prevent

a. air bells.
b. graininess.
c. water spots.
d. stains.

31. (621) Determine the cause for excessive curl during film drying.

a. Too much heat while the film was drying.
b. Omitting the fixer step during processing.
c. Opening the drying cabinet doors while the blower was on.
d. Dirt and scum in the wetting solution.

32. (622) What is the purpose of opaquing a black-and-white negative?

a. Increase printing time.
b. Eliminate pinholes and scratches.
c. Reduce processing time.
d. Add detail to the negative.

33. (623) List the factors considered when selecting negatives to be printed.

a. Focus, format, contrast.
b. Grain, exposure, size.
c. Identify, defects, contrast.
d. Speed, focus, grain.

34. (623) All negative selection factors must be based on whether the final print will be

a. mounted.
b. displayable.
c. published.
d. pleasing.

35. (624) Select the advantage of using water based ink to letter negatives.

a. It can be washed off if you make a mistake.
b. You can use smaller tipped pens.
c. Water based ink is available in more colors.
d. It is transparent and can be used on the image area.

36. (625) What is the maximum relative humidity permissable in a film storage area?

a. 10 percent.
b. 25 percent.
c. 50 percent.
d. 75 percent.

37. (626) The major part of operator maintenance in the processing room is involved with

a. replenishment.
b. cleanliness.
c. storage.
d. inspection.

38. (627) Safety in the laboratory requires electrical equipment to be

a. close to the operator.
b. on the highest shelves.
c. properly grounded.
d. on the wet side.

39. (628) What is the basic paper developer used in the Air Force?

a. DK-19.
b. DK-50.
c. D-62.
d. D-72.

40. (629) Agitation of a print in the developer should be

a. vigorous.
b. stagnant.
c. constant.
d. intermittent.

41. (630) The purpose of a stop bath is to

a. remove the antihalation backing.
b. stop or slow down development.
c. make the image permanent.
d. prolong the life of the developer.

42. (630) What are the two basic types of stop bath?

a. Water and acid.
b. Dilute and chemical.
c. Neutral and alkali.
d. Hardening and permanent.

43. (630) Which processing solution changes undeveloped silver into soluble salts?

a. Stop bath.
b. Fixing bath.
c. Hypo clearing bath.
d. Acid hardener bath.

44. (631) Select the correct statement regarding time and temperature of processing solutions.

a. As time and temperature increase density decreases.
b. As time and temperature decrease density increases.
c. As time and temperature increase density increases.
d. There is no correlation between time, temperature, and density.

45. (632) A lack of agitation in the developer may cause

a. mottle.
b. frilling.
c. high contrast.
d. high density.

46. (632) Small, circular, clear spots on a print are caused by

a. air bubbles.
b. light leaks.
c. hot developer.
d. vigorous agitation.

47. (633) Select the graded contast paper used to print a very flat negative.

a. One.
b. Two.
c. Three.
d. Four.

48. (634) Which of the following is the best way to control contrast of a print?

a. Selection of graded paper.
b. Extend the printing time.
c. Shorten the development time.
d. Use a print toner.

49. (635) Select the light color required to achieve high contrast with variable contrast paper.

a. Yellow-green.
b. Blue-violet.
c. Red-yellow.
d. Blue-green.

50. (636) Which of the folowing safelight filters should be used with variable contrast paper?

a. A (red).
b. A1 (brown).
c. OA (orange).
d. OC (amber).

51. (637) In printing papers, to which of the following does the term "surface" refer?

a. Tint and tone.
b. Finish and texture.
c. Tint and texture.
d. Tone and finish.

52. (638) A print that is to be reproduced in a newspaper should be printed on

a. matte paper.
b. semimatte paper.
c. low luster paper.
d. glossy paper.

53. (639) The tone of a print depends primarily upon

a. exposure and dodging.
b. paper and developer combination.
c. contrast and detail.
d. the negative and the reproduction.

54. (639) Which of the following enables a print to reproduce the values of a scene.

a. Proper contrast.
b. A flat negative.
c. Too much detail.
d. Too little exposure.

55. ([illegible]) In order to control contrast with variable contrast paper, which of the following must be used.

a. Graded developers.
b. Diffused light.
c. Printing filters.
d. Test strips.

56. (641) The negative and paper are held together in a contact printer by the

a. mask.
c. filter roll.
b. platen.
d. diffusion glass.

57. (641) Uniform illumination is maintained on a contact printer by using a

a. platen.
c. filter wheel.
b. argon lamps.
d. diffusion glass.

58. (642) Which of the followng can be produced by using a contact printer?

a. Proof sheet.
c. Enlargements.
b. 2 to 1 image.
d. Reductions.

59. (643) Select the projection printer which will produce the maximum amount of detail in the print.

a. Condenser.
c. Pneumatic.
b. Diffusion.
d. Mechanical.

60. (644) Which of the following lists contains components applicable only to the EN-52B projection printer?

a. Argon lamps, filter wheel, and condenser.
b. Lamphouse, lens, cone, and platen.
c. Baseboard, lens, and diffusion glass.
d. Negative carrier, lens cone, and condenser.

61. (645) What must be changed to obtain sharp focus while projection printing?

a. Lens-to-film distance.
b. Negative carrier size.
c. Cam follower wheel ratio.
d. Focal diameter of the lens.

62. (646) An easel is used to form a border and to

a. produce print texture.
b. hold the paper flat.
c. reduce paper waste.
d. eliminate dust from the negative.

63. (646) Which one of the following is used to produce white borders on contact prints?

a. Frisket.
c. Mask.
b. Pallet.
d. Easel.

64. (647) How should the frisket be placed on the easel?

a. In the upper left corner.
b. In a position that it can be [illegible].
c. With the dull side up.
d. With the sticky side down.

65. (648) Which of the following describes the proper procedure for exposing a test strip?

a. Expose each strip at the same exposure.
b. Each strip should come from a different negative area.
c. Each strip should contain the same parts of the negative.
d. Expose each strip at a different degree of enlargement.

66. (649) Select the procedure used to dodge an area of a contact print.

a. Change filters.
b. Use a transparent mask.
c. Increase the exposure time.
d. Manipulate individual printer lamps.

67. (649) Why is burning-in used in projection printing?

a. To increase local density.
b. To increase overall density.
c. To decrease local contrast.
d. To increase overall contrast.

68. (650) Select the required procedure when composing a projection print and desiring a bigger image.

a. Use a longer focal length lens.
b. Move the printer head farther from the easel.
c. Move the lens closer to the easel.
d. Change to a larger condensing lens.

69. (651) The [illegible] distortion control can be obtained by tilting the [illegible]

a. [illegible] the easel.
b. [illegible]
c. Negative and [illegible] the same axes.
d. Negative and easel [illegible]

70. (652) Which of the following is necessary to make a duplicate negative?

a. Masking film.
b. Master positive.
c. Projection printer.
d. Argon lamps.

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71. (653) How should unexposed paper be stored?

a. On end.
b. Flat.
c. Near the processing room.
d. At a humidity over 70 percent.

72. (654) If a negative carrier has burns, what should be done?

a. Throw it away.
b. Turn it inside out.
c. Tag it for maintenance.
d. File or sand them smooth.

73. (655) Which of the following lists contains factors applicable only to print washing time?

a. Exhausted fixer, type of paper, and water exchange rate.
b. Agitation, weight of paper, and length of exposure.
c. Use of hypo clearing agent, method of washing, and pH of stop bath.
d. Temperature of water, weight of paper, and time of day.

74. (656) The Pakolux should be loaded with prints one at a time to

a. insure proper count.
b. have each print go into its own slot.
c. prevent sticking together.
d. have sufficient drain time.

75. (657) Prints are treated in a predrying bath of glycerin, because this process

a. makes prints easier to mount.
b. reduces curling tendencies.
c. speeds removal of hypo.
d. hardens the emulsion.

76. (657) What is the usual cause of cracks in dry prints?

a. Too much glycerin in the softening bath.
b. Too little hardener in the fixer.
c. Rough handling of the prints.
d. Excessive humidity in the storage room.

77. (658) The sliding cover of the Pako Tempro 400 dryer should be opened to

a. vent excess humidity.
b. reduce drying time.
c. shut down the dryer.
d. override the thermostat.

78. (659) What type of mounting conditions would wet adhesives be best suited for?

a. Large hard-to-handle prints.
b. Small irregularly shaped prints.
c. Prints to be displayed for long periods of time.
d. Prints which need to be mounted for short periods of time.

79. (660) After mounting a print, the mounting board should be bent backward away from the print to

a. speed up the cooling time.
b. check for permanent adhesion.
c. check for air bubbles.
d. make the print flat.

80. (660) What will happen if too much heat is applied while mounting a print?

a. The mounting press thermostat will shut off the press.
b. The print will slip out of place in the press.
c. The mounting tissue will melt and absorb into the print.
d. The cover sheet will absorb the excess heat.

81. (661) Which of the following is the easiest method of making written information a permanent part of the print?

a. Typing.　　　　　　　　　c. Hand lettering.
b. Attaching a frisket.　　　　d. Ink stamping.

82. (662) Select the condition which would cause pock marks on a print dried on a drum dryer.

a. Dirt on the apron.
b. Improper tracking adjustment.
c. Flat entrance rollers.
d. Scratches on the drum.

83. (663) Identify the region of radiations at 400 nm.

a. Red.　　　　　　　　　c. Blue.
b. Green.　　　　　　　　d. Ultraviolet.

84. (663) What phenomenon allows a material to absorb radiation at one wavelength and emit it at another wavelength.

a. Interference.　　　　　　c. Diffusion.
b. Refraction.　　　　　　　d. Fluorescence.

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85. (663) What is the term used to describe a certain color of a subject?

a. Hue.
b. Brilliance.
c. Purity.
d. Saturation.

86. (664) What two colors of light will combine to make yellow?

a. Magenta and cyan.
b. Green and red.
c. Green and magenta.
d. Blue and red.

87. (665) Select the color of light which a cyan filter will absorb.

a. Red.
b. Green.
c. Blue.
d. Cyan.

88. (666) What color of light will the middle layer of color film record?

a. Red.
b. Yellow.
c. Blue.
d. Green.

89. (666) Daylight color film is extra sensitive to which color of light?

a. Red.
b. Blue.
c. Magenta.
d. Yellow.

90. (666) Which of the following is required to use tungsten film in daylight?

a. Increase exposure.
b. Increase development time.
c. Use appropriate conversion filter.
d. Use blue filtered light source.

91. (667) Select the proper temperature in the storage area when storing color film longer than 6 months.

a. 55° to 75°F.
b. 45° to 65°F.
c. 25° to 35°F.
d. 0° to -10°F.

92. (667) Which of the following storage conditions is most likely to cause dye changes in color film?

a. High temperature.
b. High humidity.
c. Low temperature.
d. Low humidity.

93. (668) What is the effect of [illegible] color [illegible]?

a. A color shift toward red.
b. A color shift toward green.
c. Highly saturated colors.
d. Washed out pastel colors.

94. (669) Select the filter used to expose daylight color film under tungsten light.

a. Compensating.
b. Conversion.
c. Light balancing.
d. Special.

95. (670) Which of the following is a feature of the Repronar color duplicating camera?

a. Quartz light source.
b. Automatic exposure control.
c. Groundglass focusing.
d. [illegible] film capacity.

96. (671) To copy a slide that is one stop underexposed, what change must be made from the normal exposure?

a. Open up one stop.
b. Open up two stops.
c. Close down one stop.
d. Close down two stops.

97. (672) Which step of the E-6 process produces a visible metallic silver image?

a. First developer.
b. Reversal bath.
c. Color developer.
d. Conditioner.

98. (675) What is the maximum storage time for [illegible]?

a. [illegible] weeks.
b. 8 weeks.
c. [illegible] weeks.
d. 24 weeks.

99. [illegible]

a. [illegible]
b. [illegible]
c. [illegible]
d. [illegible]

100. [illegible]

a. [illegible] to 20%.
b. [illegible] to 30%.
c. [illegible]
d. [illegible]

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101. (676) Select the correct statement regarding a plastic with glass slide mounts.

a. They have superb impact resistance.
b. They are cheaper than metal with glass mounts.
d. Newton Rings are not a problem with plastic and glass mounts.
d. Waterproof tape must be used with plastic and glass mounts.

102. (676) What is the principal disadvantage of glassless slide mounts?

a. Loss of protection. c. Prohibitive cost.
b. Newton ring formation. d. Unadaptable to equipment.

103. (677) What is needed to seal carboard mounts?

a. Glue and pressure. c. Heat and pressure.
b. Tape and pressure. d. Tape and heat.

104. (678) In which of the following rooms would it be most desirable to have a chemical-free environment?

a. Projection printing. c. Film loading.
b. Finishing. d. Storage.

105. (678) At what point do negatives require the least amount of protection?

a. During down loading. c. While hanging up to dry.
b. After they are dry. d. Just before processing.

106. (679) Select the correct procedure to prevent the formation of small, irregularly shaped transparent spots on your negatives.

a. Use of a tripod during exposure.
b. Increase initial agitation in the developer.
c. Lower the processing temperatures.
d. Clean the interior of the camera.

107. (679) Improper agitation of a print in the acid stop bath will cause

a. blisters. c. purple discolorations.
b. reticulation. d. grayish mottle.

108. (680) What is the science of analyzing the effects of exposure and processing on photographic materials?

a. Sensitometry. c. Photo chemistry.
b. Densitometry. d. Variability.

[illegible] effect on the developing image?

a. Sulfite. c. [illegible]
b. Sulfide. d. [illegible]

[illegible] replenisher?

[illegible] [illegible]
[illegible] [illegible]

[illegible] the most sensitive to [illegible]

[illegible] glass. [illegible]
Sodium sulfite. Oxidation.

[illegible] is associated with a fixing [illegible] after the [illegible]?

[illegible] [illegible] becomes [illegible]
[illegible] [illegible]
[illegible] [illegible]
d. [illegible]

[illegible] container [illegible] photographic chemistry should be made of

a. [illegible] c. Amber glass.
b. [illegible] d. Porous copper.

[illegible] What is the maximum laboratory storage time?

[illegible] c. [illegible] months.
[illegible] d. [illegible]

[illegible] to store [illegible]

[illegible] [illegible]
[illegible] [illegible]

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STUDENT REQUEST FOR ASSISTANCE

PRIVACY ACT STATEMENT

AUTHORITY: 44 USC 3101. PRINCIPAL PURPOSE(S): To provide student assistance as requested by individual students. ROUTINE USES: This form is shipped with every ECI course package. It is utilized by the student, as needed, to place an inquiry with ECI. DISCLOSURE: Voluntary. The information requested on this form is needed for expeditious handling of the student's need. Failure to provide all information would result in slower action or inability to provide assistance.

SECTION I: CORRECTED OR LATEST ENROLLMENT DATA: MAIL TO ECI GUNTER AFS, ALA 36118

1. THIS REQUEST CONCERNS COURSE
2. TODAY'S DATE
3. ENROLLMENT DATE
4. PREVIOUS SERIAL NUMBER
5. SOCIAL SECURITY NUMBER ☐☐☐ – ☐☐ – ☐☐☐☐
6. GRADE/RANK
7. INITIALS ☐ ☐ LAST NAME
8. OTHER ECI COURSES NOW ENROLLED IN
9. ADDRESS: (OJT ENROLLEES - ADDRESS OF UNIT TRAINING OFFICE/ALL OTHERS - CURRENT MAILING ADDRESS)

ZIP CODE ☐☐☐☐☐

10. NAME OF BASE OR INSTALLATION IF NOT SHOWN ABOVE:
11. AUTOVON NUMBER
12. TEST CONTROL OFFICE ZIP CODE/SHRED

SECTION II: Old or INCORRECT ENROLLMENT DATA

1. NAME:
2. GRADE/RANK:
3. SSAN:
4. ADDRESS:
5. TEST OFFICE ZIP/SHRED:

SECTION III: REQUEST FOR MATERIALS, RECORDS, OR SERVICE

(Place an "X" through number in box to left of service requested)

ADDITIONAL FORMS 17 available from trainers, OJT and Education Offices, and ECI. The latest course workbooks have a Form 17 printed on the last page.

1 EXTEND COURSE COMPLETION DATE. (Justify in Remarks)

2 SEND VRE ANSWER SHEETS FOR VOL(s): 1 2 3 4 5 6 7 8 9 - ORIGINALS WERE: NOT RECEIVED, LOST, MISUSED

3 SEND COURSE MATERIALS (Specify in remarks) - ORIGINALS WERE: NOT RECEIVED, LOST, DAMAGED.

4 COURSE EXAM NOT YET RECEIVED. FINAL VRE SUBMITTED FOR GRADING ON (Date):

5 RESULTS FOR VRE VOL(s): 1 2 3 4 5 6 7 8 9 NOT YET RECEIVED. ANSWER SHEET(s) SUBMITTED ON (Date):

6 RESULTS FOR CE NOT YET RECEIVED. ANSWER SHEET SUBMITTED TO ECI ON (Date):

7 PREVIOUS INQUIRY (ECI FORM 17, LTR, MSG) SENT TO ECI ON:

8 GIVE INSTRUCTIONAL ASSISTANCE AS REQUESTED ON REVERSE:

9 OTHER (Explain fully in remarks)

REMARKS: (Continue on Reverse)

OJT STUDENTS must have their OJT Administrator certify this request.

ALL OTHER STUDENTS may certify their own requests.

I certify that the information on this form is accurate and that this request cannot be answered at this station. (Signature)

ECI FORM 17 JUN 77 PREVIOUS EDITIONS MAY BE USED

SECTION IV: REQUEST FOR INSTRUCTOR ASSISTANCE

NOTE: Questions or comments [illegible] [illegible] [illegible] [illegible] [illegible] directly to [illegible] [illegible] [illegible]. All other inquiries concerning the course should be forwarded to [illegible].

VRE ITEM QUESTION [illegible] MY QUESTION [illegible]

Course No. ________

Volume No. ________

VRE Form No. ________

VRE Item No. ________

Answer [illegible] [illegible] ________

[illegible] answer sheet [illegible] for grading:

☐ [illegible] ☐ [illegible]

REFERENCE [illegible]
[illegible] [illegible] for the
answer [illegible]
[illegible]

[illegible] ________

[illegible] ________

[illegible] ________ [illegible] ________ [illegible]

[illegible] ________

REMARKS

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ATC/ECI SURVEY

The remaining questions (125-135) are not part of the Volume Review Exercise (VRE). These questions are a voluntary ATC/ECI survey. Using a number 2 pencil, indicate what you consider to be the appropriate response to each survey question on your answer sheet (ECI Form 35), beginning with answer number 125. Do not respond to questions that do not apply to you. Your cooperation in completing this survey is greatly appreciated by ATC and ECI. (AUSCN 100)

PRIVACY ACT STATEMENT

A. Authority: 5 U.S.C. 301, Departmental Regulations

B. Principal Purpose: To gather preliminary data evaluating the ATC/ECI Career Development Course (CDC) Program.

C. Routine Uses: Determine the requirement for comprehensive evaluations in support of CDC program improvement.

D. Whether Disclosure is Mandatory or Voluntary: Participation in this survey is entirely voluntary.

E. Effect on the Individual of not Providing Information: No adverse action will be taken against any individual who elects not to participate in any or all parts of this survey.

QUESTIONS:

125. If you have contacted ECI for any reason during your enrollment, how would you describe the service provided to you?

a. Excellent.
b. Satisfactory.
c. Unsatisfactory.
d. Did not contact ECI.

126. My ECI course materials were received within a reasonable period of time.

a. Strongly agree.
b. Agree.
c. Disagree.
d. Strongly disagree.

127. The condition of the course materials I received from ECI was:

a. A complete set of well-packaged materials.
b. An incomplete set of well-packaged materials.
c. A complete set of poorly packaged materials.
d. An incomplete set of poorly packaged materials.

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128. The reading level of the material in this course was too difficult for me.

a. Strongly agree. c. Disagree.
b. Agree. d. Disagree.

129. The technical material in the course was too [illegible] for me at my present level of training.

a. Strongly agree. c. Disagree.
b. Agree. d. Strongly disagree.

[illegible] The illustrations in the course [illegible] for me.

a. Strongly agree. c. Disagree.
b. Agree. d. Strongly disagree.

[illegible] Approximately [illegible] information in the course provided general information about your AFSC?

a. Between 80 and 99%. c. Between 4[illegible]
b. Between [illegible] and [illegible]%. d. Between 2[illegible]

[illegible] Approximately how much information in this course is current?

a. Between 80 and [illegible] c. Between [illegible] and 59%.
b. Between 60 and 79%. d. Between 2[illegible] and 39%.

[illegible] the examples helped me [illegible]

a. Strongly agree. c. Disagree.
b. Agree. d. Strongly disagree.

[illegible]

a. Strongly agree. c. Disagree.
b. Agree. d. Strongly disagree.

[illegible]

a. Excellent. c. [illegible]
b. Satisfactory. d. Unsatisfactory.

NOTE: If you know this CDC contains outdated information or does not provide the knowledge that the current Specialty Training Standard requires you to have for upgrade training, contact your OJT advisor and fill out an AF Form 1284, Training Quality Report.

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